THE MODEL ENGINEER

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THE MODEL ENGINEER

EVERY THURSDAY

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Our Cover Picture

This photograph was taken by Mr. C. H. Cheslin, of the West Hartlepool Society of Model Engineers, and submitted by a fellow member, Mr. A. C. Lamb, who features in the picture. The job in progress is a part of the spindle for a grinding and milling spindle of the lathe cross-slide. Many readers may be interested in the lathe itself, which is of local manufacture; it is 2-in. centre height and takes a maximum length of 6-in. between centres. The adjustable tool-post shown was milled from solid steel on the lathe itself, and various parts for the lathe, including the leadscrew dog-clutch, were made on the same machine. Automatic feed is obtained by belt drive from a small pulley on the end of the mandrel, to a large pulley which drives a train of gears to provide the required reduction to the leadscrew. Other ingenious features of the lathe installation include the belt tensioning device, utilising a movable motor platform, and resilient mounting of the entire assembly on sponge rubber pads.

SMOKE RINGS

A Hat-trick ?

THE BIRMINGHAM Ship Models Society has every appearance of making a determined effort to win the "M.E." Club Championship Cup, for the third time in succession, by entering three first-class exhibits for the contest at this year's "M.E." Exhibition. The entries comprise two ships' boats by F. A. A. Pariser, a carvel-built yawl and clinker-built beach boat by A. E. Field, and a Shetland sixern by C. J. Clarke. To judge by our recollections of the B.S.M. society's efforts at the two previous "M.E." Exhibitions, there appears to be every chance of a "hat-trick" being achieved.

Incidentally, we are pleased to announce that a prize consisting of a set of castings for "Titfield Thunderbolt," to be awarded at the discretion of the judges, has been made possible by the generosity of Mr. W. K. Waugh of Bearsden, Glasgow.

Invitation from Malden

THE MALDEN and District Society of Model Engineers will be holding its usual "Locomotive Gala" on the Sunday during the "M.E." Exhibition. A cordial invitation is extended to all who can take along locomotives. The society's track is at Thames Ditton, alongside the Southern Region main line, just at the place where the branch to Hampton Court diverges. Owners of 3½ in. and 5 in. gauge locomotives are especially welcome, and should make a note of the date—August 23rd.

Royalty on the Railway

WE VISITED the British Transport Commission's "Royal Journey" exhibition during its run a week or two ago, and, although it was not very extensive, we found much that gave us a lot of food for thought. Surely, there can be little doubt that, in these hectic days, we are missing something in grandeur of decoration and sheer craftsmanship of construction. Granted that much of the earlier Victorian magnificence was purely flamboyant and useless; but the exhibition showed that this tendency gave way to a style which achieved a superb combination of dignity and utility, devoid of any suggestion of mere showiness, that has been maintained from about the 1880s until the present day.

The only full-size locomotive in this delightful little exhibition was the old Caledonian Railway's celebrated single-wheeler No. 123. We were told that this charming old engine had recently been specially re-painted for this show; but it was clear that she sadly lacked anything like the superb finish that was once hers, and we could not help thinking what a poor show she would make were she to resume "Royal Train Pilot" duty !

Probably, the gem of the exhibition was the old London and North Western Royal saloon which was the result of an ingenious reconstruction undertaken at Wolverton in 1895, when two older saloons were combined together on one frame to produce what can only be described as a triumph of the coach-builder's art. This beautiful vehicle, mounted on two 6-wheeled bogies, is still in its original paint, and all its internal furnishings and decorations remain unaltered. It shows us what can be done in the way of providing a maximum of comfort and convenience without impairing utility, and clothing them, so to speak, in a bright and attractive colour scheme devoid of ostentation. It is the embodiment of dignity and grace without overstepping the bounds of decorum.

Some extremely interesting documents, prints, photographs, relics and models were housed in two vans. At one end of one of the vans there was a full-size model of part of the interior of Queen Victoria's saloon on the old G.W.R. Royal Train of 1897, with all its beautiful decoration faithfully reproduced—a study in cream and gold.

L.B.S.C.'s Lobby Chat

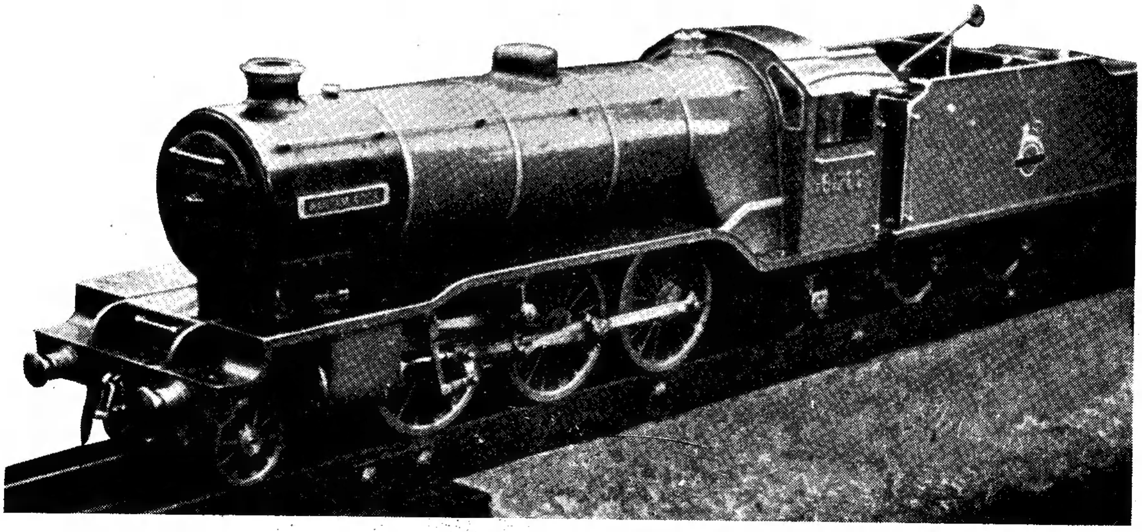
● "QUEEN MABEL'S" VALVE GEAR

SUGGESTIONS have come in from various sources, that when the *Britannia* serial is finished, which won't take very long now, as there are only some details, and the tender, to describe, the next item on the programme should be a 3½-in. gauge *Queen Mabel.* The lads of the villages jocularly remark that it would literally "pull a fast one" on British Railways! Well, I've had quite a lot of correspondence about this "dream" engine. Although, as I mentioned some time ago, many good folk are sceptical about a speed of 180 m.p.h. being within the bounds of possibility, others are convinced that it *is* quite feasible, given a properly-balanced engine which would hold the road safely at the high speed. Among these are several top-link drivers of all regions of British Railways, and if anybody is entitled to give an opinion by virtue of experience, I guess they are! The whole question then boils down to two factors; one, getting steam in and out of the cylinders quick enough to enable the high revolution rate to be maintained; and two, the ability of the boiler to supply steam fast enough. Let's go into matters with a bit more of the "Curly simple analysis."

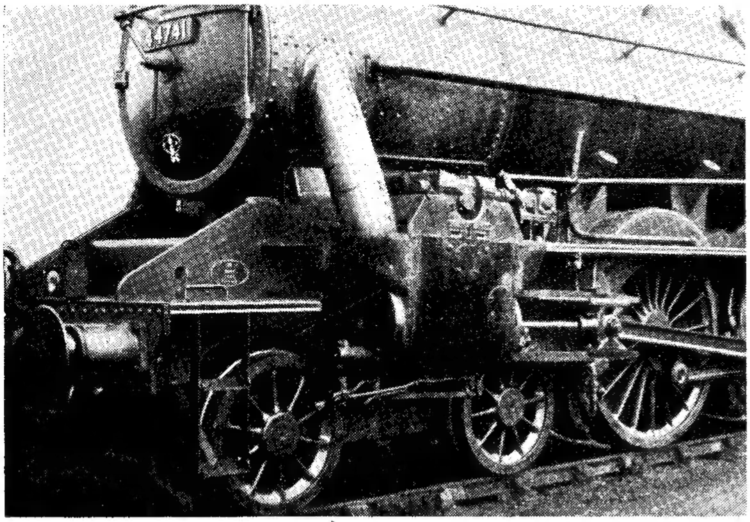
All readers of the tales will have noticed that *Queen Mabel* had a special arrangement of valve gear —"Sir Roy's patent accelerator device"—which gave an hitherto unheard-of lead, practically a full port opening, without any pre-admission trouble. This has caused some head-scratching, and correspondents ask if it is really possible. If so, and combined with quick-acting variable exhaust release, the No. 1 factor mentioned above, is solved. Yes! It is not only possible, but a practical proposition; in fact, it can be done in several ways. It would be a fairly simple matter with a poppet-valve gear, for example; but I don't favour poppet-valves, in the case of steam locomotives. They are good enough for my gas buggy, the cylinders of which are 2¾ in. bore and 4 in. stroke, with valves not much bigger than a penny; but *Queen Mabel's* 20 in. × 28 in. cylinders would need valves at least 10 in. diameter, and at three miles per minute, the kettledrum-like concussion would be so terrific, that I wouldn't expect them to last more than the proverbial five minutes. Even if they stood up to the awful hammering, they wouldn't remain steam-tight. Piston-valves blow as soon as the rings start to wear, and any driver will tell you how a blow in the steamchest affects speed, power, and coal and water consumption. In passing, I have heard from several sources, that the French compounds usually work better when the high-pressure valves are blowing a bit. Extra steam gets along to the low-pressure cylinders, and gives a little heftier kick to the big pistons! Truly, it's an ill wind that blows nobody good.

Ways and Means

Piston-valves can be made to open the ports all-of-a-sudden-Peggy by fitting either an auxiliary device to the valve-gear, the valves themselves, or both. Mr. W. B. Hockings, who was a Southern engineman before he took to the drawing-office of a well-known engineering firm, devised an arrangement worked from the combination lever. In this, the admission valve was moved direct by the valve-gear for a distance



"Old Faithful"—and Mr. Eccles didn't say who built her!



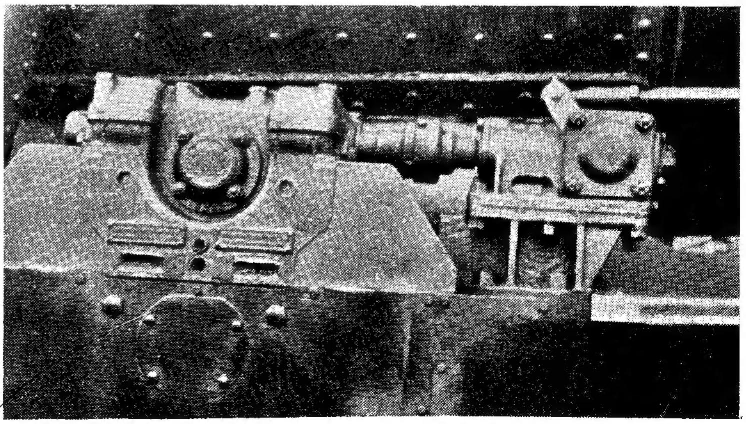
Class 5 front end with poppet-valve cylinder

equal to the lap; a servo-cylinder then took command, and smacked the valve over to a full port opening, practically instantaneously. The whole business of admission and cut-off, is worked by a tiny auxiliary cylinder of about 1¼ in. bore, with a spring-controlled valve. He sent me a drawing of the arrangement; and as far as I could see, there was nothing to cause trouble in operation. Naturally, it was a little more complicated than if the valves had been operated direct from the gear; but you can't have it all ways, and there was no more complication than in an ordinary poppet-valve gear with camshaft, and the box of tricks necessary for notching up and reversing.

In the description of *Lady Vera* and *Queen Mabel* in the tales, it was stated that the outside valve-gear was "Baker-Donalot," and the inside, Holcroft's final conjugation. The former was one of your humble servant's wangles, schemed out in conjunction with the original of "Sir Roy." Incidentally, all the characters in the tales were based on living persons, much to their amusement and satisfaction, but there won't be any more of them. Alas, "Lady Vera" suddenly passed to the Great Beyond, early this year, and I haven't now any heart to carry on. Our good friends of the erstwhile L.N.E.R. said it was about time that *Queen Mabel* and her feminine crew made a bit of a splash on their road, and what about it; so I was cooking up a real snorter, featuring a through run from the Southern line to Edinburgh with a distinguished visitors' special, combining excitement, speed and drama. However, that train is now cancelled; nuff sed.

Returning to the valve-gear, the "Baker-Donalot" was, in effect, the Baker gear modified to drive an oscillating-cam arrangement, something like the Lentz, but using a divided piston-valve instead of poppets. This gave practically an instantaneous full port opening as the crank arrived at dead-centre, and an equally quick closing, with the same infinitely-variable cut-off as the ordinary gear. The quick action was transmitted by the Holcroft conjugation, to the single inside valve of *Lady Vera*, and the two inside valves of the four-cylinder *Queen Mabel*. The exhaust valves were entirely independent, and were operated by an eccentric-and-link device; the large diameter of the valves and ports, plus a rapid opening, gave the requisite freedom, the valve gear merely altering the percentage of the stroke at which exhaust took place. As this was exactly the same whichever way the engine was running, no separate reversing gear was necessary on the exhaust side; and although the arrangement automatically provided for a variable exhaust when running backwards, it would only have been of use on a tank engine. The only time a tender engine "goes astern," as our nautical friends would say, is when shunting, running light, or maybe pulling a load of empties to the terminal station, or carriage sidings; all slow-speed jobs.

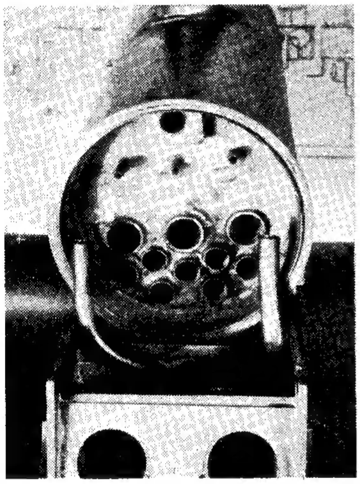
Should it come to pass, by virtue of circumstances, and the blessing of the K.B.P. that I describe how to build a little *Queen Mabel*, I shall then, all being well, give fully detailed drawings of the "thunder-and-lightning" valve-gear, and once more put the cat among the pigeons; but until that time, I prefer to keep the "ace of trumps" up my sleeve, as the saying goes, for reasons which our older readers will appreciate. As to the capacity of the boiler to supply steam, the boiler of the full-sized *Queen Mabel* would have nearly 4,000 sq. ft. of heating surface; and with my specified arrangement of firebox, combustion chamber, tubes and flues, superheater, and of course, a mechanical stoker, it would have no trouble in doing the needful with steam at 260 lb. pressure, and about 700 or more degrees of superheat. The engine could be handled easily by a real-life Driver Joy and Fireman Alice—a far easier job than ferrying aircraft across the Atlantic Ocean, a job which women have successfully managed.



A real box of tricks

Caprotti Valve-gear on Class "5"

Before leaving the subject of valve-gears, the reproduced photographs may be of interest, as they show close-up views of the Caprotti valve-gear on L.M.S. class "5" engine No. 44741. They were taken by Fred Lanquer and kindly forwarded by friend E. W. Eccles. The gear is of the rotary cam type, driven from a longitudinal shaft worked by bevel gears from the driving axle. The absence of the familiar Walschaerts bits and pieces outside the frames, gives a kind of "hidden mysteries" impression, and old-time enginemen would have been mighty suspicious about what



Sad errors !

was going on inside the box on top of the cylinder! I have heard varied reports about the performances of these poppet-valve engines, some favourable, some not, but all seem to agree that they run very freely. That is one result of a separate free exhaust. It is said that the rapid concussion of the valves on the seats causes leakage, but I don't see how this can very well be avoided. The divided piston valve arrangement specified for *Queen Mabel* avoids concussion.

Mr. Eccles says that the *Bantam Cock* is the old reliable standby of the Winton Park track, and is a splendid hauler.

What a Pity!

In a long letter from an overseas club secretary, he mentioned that one of the club members was an L.B. & S.C.R. fan, and was building a *Gladstone* to 4¾-in. gauge. In my reply, I asked the secretary to give the builder my address, and tell him to write me if he needed any information; also, that I would like to have a photograph of the job, if any were available. Soon after, I received a letter from the builder, who said he had got out the design from full-size dimensions and drawings published in a British engineering journal at the time the engines were new. He gave me particulars of the sizes he had adopted for his small edition; but when I read about his boiler and cylinders, I nearly shed tears of acid pickle. In all good faith, and by listening to other folks' advice, and so on, he had dropped the firebox crown-sheet to the level of the boiler centre-line, and reduced the bore of the cylinders to 1¼ in. The reduced height of the firebox crown not only skimped the heating surface in the most valuable part of the boiler, but destroyed the combustion-chamber effect of a firebox with a reasonably high crown-sheet; and it absolutely cattled the tube arrangement, as you can see from the reproduced photographs.

The diameter of the full-sized boiler, was to the best of my recollection, 4 ft. 6 in. outside the largest ring. This would have allowed our friend to use the barrel and tube arrangement shown on pages 650 and 651 of May 28th issue, and given him the proper amount of firebox volume, three double-element superheater flues in place of his three singles, and fifteen firetubes in place of the seven shown; over twice the heating surface, and twice the superheating surface! The arrangement of the bottom rows of tubes, would have allowed of his firebox being narrowed in, to suit the 4¾-in. gauge frames. I have already explained that this firebox and tube assembly could be used with a round-top casing.

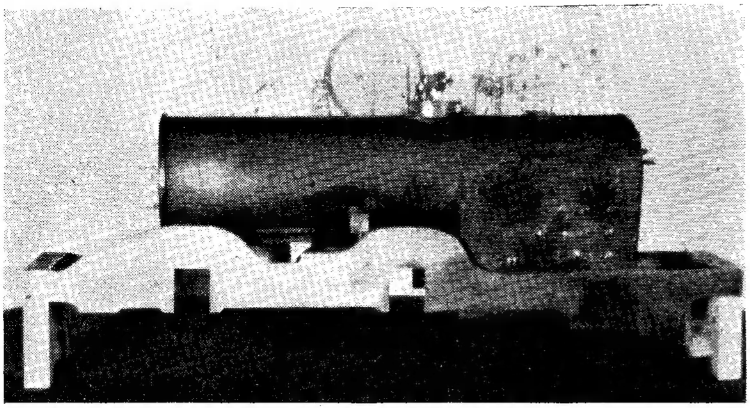
The cylinders on the big sisters were 18¼ in. × 26 in. so those in the present case should have been at least 1½ in. × 2⅛ in. I should have recommended 1⅝ in. × 2¼ in. I am specifying cylinders 1¼ in. diameter for the old *Titfield Thunderbolt*, in the 5 in. gauge size! Now the trouble to which the builder has gone, to make his hornblocks and other components, to the correct Stroudley pattern, is just nobody's business. He made special hornblock patterns, took endless pains with the moulds, and made the castings in a laboratory by the Thermit process, so as to have everything "spot-on." His other work is equally first-class, so that it grieves your humble servant no end, to think that the engine will be nothing like the performer that it should be, on account of the inefficient boiler, and the undersized cylinders. I don't suppose our friend wants to "go back on the job" in a manner of speaking, but I can honestly assure him that it would be well worth his while to make a fresh boiler and cylinders, to the dimensions as given above. He proposes, when the *Gladstone* engine is completed, to build a Stroudley class "C" 0-6-0 goods engine. If he does, I sincerely hope he won't repeat the boiler and cylinder error (the class "Cs" had the same sized boiler and cylinders as the "Gladstones"), but will make them as recommended.

I trust that nobody will run away with the idea that I am criticising this job just for the sake of finding fault; far from me be any such intention; but several of my correspondents are interested in the L.B. & S.C.Ry. engines of Stroudley design, and some are likely to start building in the near future. If so, the above comments on boiler and cylinders, may prevent their falling into a similar trap.

Why Do They Do It?

The other evening, the chairman, secretary, and another member of the Croydon S.M.E. came along to have a run on my road. The chairman, who happens to be Mr. F. C. Miles, of "Onward" fame, brought his Stirling 8 ft. single-wheeler; the secretary brought the club engine, and the member brought an unfinished *Invicta* for inspection. The single-wheeler is a fine job. Steam was quickly raised by aid of a battery-operated fan blower, and she was soon running up and down my high-level line, the 108 ft. of straight road which will take engines up to 7¼ in. gauge. The continuous line will only take engines up to 3½-in. gauge. I took a turn at driving her, and everything went fine, except the injector, which just wouldn't; when water wasn't going on the ground, steam was blowing from the overflow.

The club engine was next steamed up. She is an 0-6-0 built to A. J. Reeves's drawings for *Gert*, from "Reevesco" castings and materials. The lion's share of the building was done by the energetic secretary, Mr. E. R. Van Cooten, and an excellent job he made of it, too. This design is somewhat unique, as it incorporates a wide firebox, which is completely hidden by the side tanks; she was designed by Roy Donaldson, using components



The start of a "Gladstone"

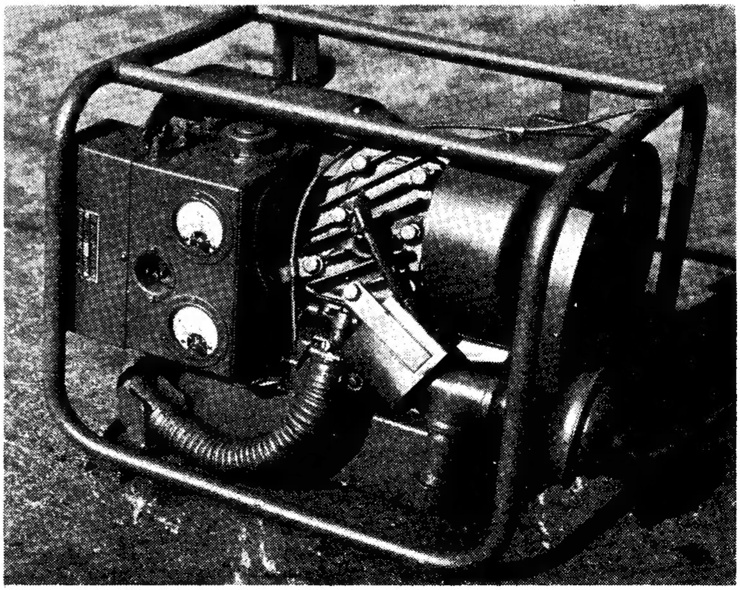
described in these notes. The cylinders are outside, but the valve-gear is inside, a combination very suitable for an engine used for "public service" work, such as passenger-hauling at fetes. The valve-gear is similar to that on *Maisie*, and well out of the way of accidental damage. Fete grounds are not always the most suitable places for setting up a railway, and derailments are likely to occur on a line that isn't level; this might play havoc with an exposed valve-gear. The locomotive is nicknamed *Pop*, as a compliment to the president of the club, who is over 80 years of age. *Pop* popped along in fine style, running equally well in either direction, making plenty of steam, with nice even exhaust beats; she is a credit to her designer and builders; but sad to relate, her injector was nothing to write home about, either !

Finally, I steamed up old *Tishy*, so that my visitors could have a go on my non-stop, and see the automatic signals do their stuff. *Tishy's* injector made them open their eyes a bit. Just to show that it would restart automatically if it "knocked off," I turned the water on and off several times in succession, leaving the steam-valve wide open, so that steam blew from the overflow. As soon as the water-valve was reopened, the injector picked up again instantly, with no loss of water at all from the overflow. Of course, that did it—and I've let myself in for the job of making a similar one as a present for *Pop*, and the correction of the one on the Stirling. Mr. Miles took this off, and left it with me for that purpose. He didn't make it himself; it was the work of another member of the club.

When I had a chance to examine it, the result prompted the caption of this paragraph. The cones weren't so bad, but the body—gee-whiz ! After all I've said about the necessity to keep an injector body cool, and giving explicit instructions as to how it should be made, this one was made from a solid chunk of brass, and was about twice the weight of one made to my specification. On top of that, the delivery clack was also very "Bill Massive," with a heavy square base. With all this mass of heat-retaining metal, it was no wonder that the gadget failed to percolate. The water running through, couldn't keep it cool, even if the cones had been O.K., and as the steam wouldn't condense properly, either steam or hot water blew from the overflow. I'll have to give the body a slimming course, as well as new cones—injector makers, please take heed !

PORTABLE ELECTRIC GENERATORS

The Teddington Engineering Co. Ltd., 29-31, High Street, Teddington, Middx, have sent us particulars of the Johnson "Chore Horse" self-starting a.c./d.c. petrol driven portable generator. This incorporates a side-valve blower-cooled four-stroke engine of 2¼ in. bore by 1⅞ in. stroke, with flywheel magneto, compensated carburettor, governor, and starting pulley. The generator produces 250 to 300 watts at 220 to 250 volts a.c., single-phase, 50 to 60 cycles, plus 300 watts at 12 to 15 volts. A self-starting circuit enables the generator to be motored from 12-volt storage batteries. An instrument panel is provided with 100 to 300 volt a.c. voltmeter, 30-0-30 charge and discharge d.c. ammeter, starter button, cut-out, rheostat, auto voltage control, etc. The electrical circuits are suppressed to prevent radio interference and the set can be used as a power pack for radio or television receivers. Overall dimensions are 17 in. × 15½ in. × 14 in. and weight complete 124 lb



FLASH STEAMERS

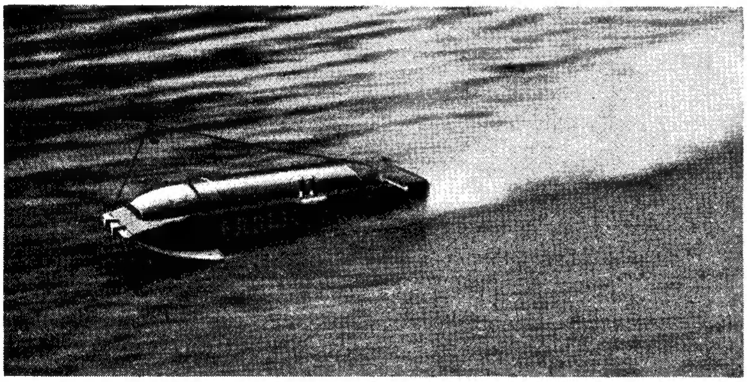
● A CHRONICLE OF EXPERIMENTS, TRIALS AND TRIBULATIONS

By B. J. Pilliner

CLIPS are fitted to cover one row of holes on each flame tube of the blowlamp when using paraffin and petrol in equal proportions, the mixture which has been used all last season. There is a considerable amount of hit and miss about tuning the lamp when it is out of the boat, as conditions are quite different from those when running, but the air admission to the tubes has been found by running the lamp flat out on the bench and giving the maximum amount of air that can be used without blowing out the burners. Too little air results in a proportion of yellow in the flames. When making the above test, fuel feed must be at approximately the same rate as when running, as a lower feed rate allows more air opening to be given.

Incidentally, venturi type trumpet-shaped tubes have been tried, and were very nice on the bench, but were found very susceptible to draught at the air intakes of the venturis. I am by no means satisfied with the arrangement of the blowlamp, and the air intakes to the flame tubes and boiler casing as a whole. A set-up to simulate running conditions on the bench would be invaluable, as diagnosis of combustion trouble at the pond is extremely difficult, and requires a lot of patience with some luck thrown in. Running at dusk, or on a very dull day, is the best time to see the flames, and one can see if they are right or wrong. They are almost invariably wrong, and even after a fair amount of experience it is difficult to diagnose the cause. For example, yellow flames can be caused by too little air (rich mixture), or partial fuel pump failure (presumably weak mixture). The latter would not normally be expected to give this result, and is apparently due to the jet pressure being below the point at which the flame tubes can mix the air with the fuel effectively.

Fuel tank—"Frolic." This is made of 0.005-in. brass foil and is 1⅝ in. diameter, 8¾ in. long. To allow for centrifugal force the filler is on the nearside, and the outlet on the offside of the boat. The total capacity is sufficient to a 1,000 yard event, and normally the tank is filled to two-thirds capacity for 500 yards, giving a running distance of 700-800 yards after a 1½ lap start.



At the Southampton Regatta, 1952—58 m.p.h. New air scoop has been fitted

Fuel Pumps—"Ginger" and "Frolic."—The hand pump is 5/16 in. bore × ½ in. stroke, identical with that for water, and is mounted on the side of the boat. Generally conventional in design, the only particular feature is that operation is direct, with the thumb on a pad attached to the pump ram, the ram being returned by a spring, and retained by the gland nut, which is recessed for this purpose. Body and gland nut are made of dural, ram of stainless steel, and valve boxes of brass, with stainless steel balls. Incidentally, the valves are made from ⅛ in. gas double-ended union bodies, this thread being used on most of the plumbing throughout.

Piping to and from the pumps is 3/16 in. dia., the hand and mechanical pumps being in series, with the tank feeding to the hand pump. This arrangement ensures priming of the mechanical pump, and is similar for fuel and water feeds. There is a little electrolytic action between the brass and dural on the pumps, but not sufficient to be troublesome. The mechanical fuel pump, 3/16 in. bore × 0.2 in. stroke, is mounted on the crankshaft housing, together with its counterpart for water feed. Both are driven by a spur reduction of 2.8 : 1, which means that with present boat speeds they are now running at a maximum of around 3,000 r.p.m. Although this high speed does not appear to cause any trouble, it was not anticipated when the pumps were made and the gear ratio decided. The fuel pump has a bronze body, gland nut and valve boxes, with stainless ram and balls. The balls, 5/32 in. diameter inlet, ⅛ in. diameter delivery, are restricted in lift to 0.012 in., and caged to ensure that they cannot move sideways, and to minimise clearance volume. This pump started life as an experimental water pump, to be driven at engine speed, and was originally fitted with disc valves of 0.006 in. beryllium copper. These were found difficult to keep tight, due, apparently, to their light weight and the rather large seating area.

A great deal of elusive trouble was caused in 1951, *Frolic's* first season, by this pump. This was eventually found to be due to vaporising of the fuel (petrol) in the pump itself, and occurred after three or four laps, reducing the pump output and the boat's speed. It took about three months to diagnose the trouble, as checks of fuel consumption were rather misleading, due to the varying amount that is used starting up. The point was finally proved by taking some runs on pure paraffin, which gave a steady speed throughout the run. The pump was then jacketed and is now cooled (although, it is suspected, not very efficiently) by the overflow from the water tank. Unfortunately,

Continued from page 105, July 23, 1953.

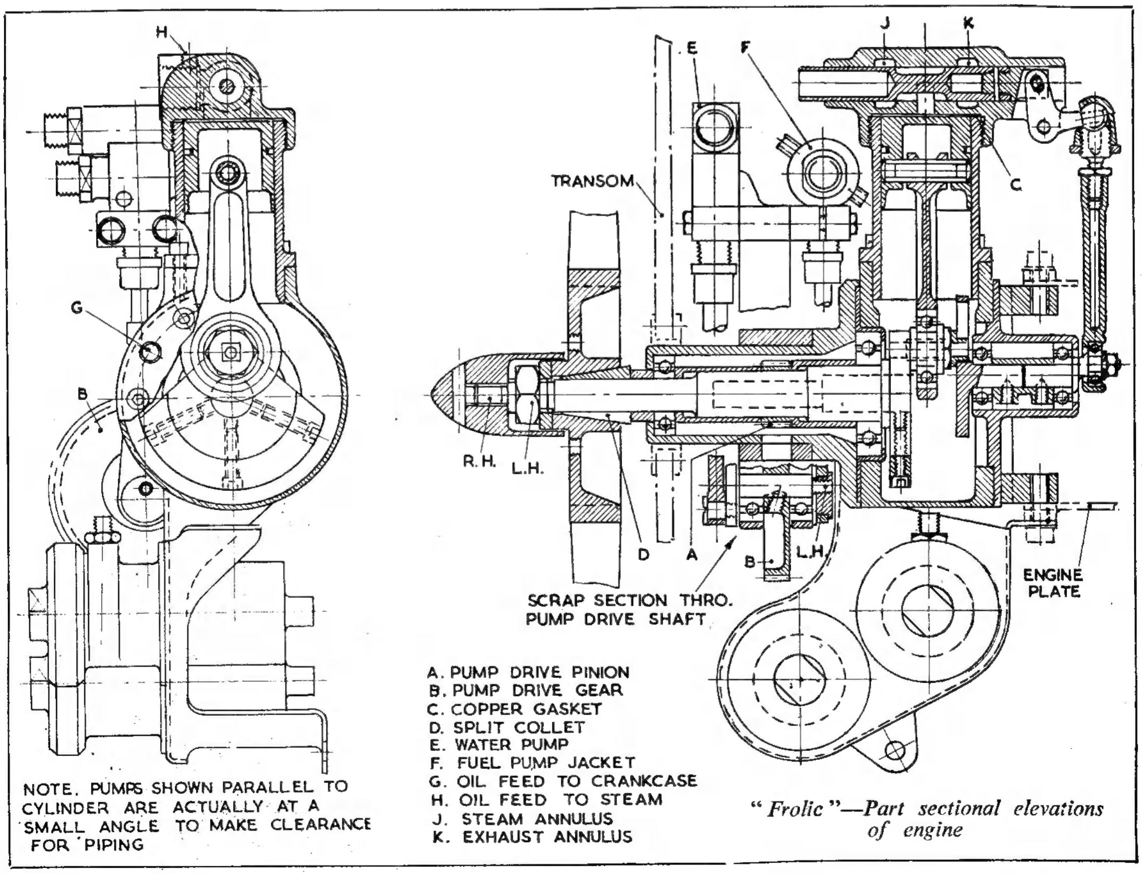
this pump gains a lot of heat through the dural crankcase and mounting, and is also close to the cylinder head.

The vaporising trouble occurred with blowlamp fuel or petrol when the pump could be described as warm, rather than hot, to the hand, and was apparently due in part to the lowered pressure of the fuel on the suction stroke of the pump. Bench testing would have obvious advantages in diagnosing and eliminating this sort of trouble.

I notice that I have used rather a lot of space in this description of the blowlamp. Most of the elusive troubles I have had (and still have !) are centred round it, and it rates in my opinion as the No. 1 flash steam "bug," owing to the difficulty of finding out just what is happening when the boat is running.

The table which appeared in the previous article, shows that each boat to date has had a different boiler. The first change from $\frac{3}{8}$ in. to $\frac{1}{4}$ in. tubing was made as it was obvious that the first boiler was cumbersome and inefficient, due to difficulty of coiling the tube to a diameter small enough to be effectively heated by the torch-type lamp, which gives rather concentrated flames for some distance from the flame tubes. Subsequent changes were made to suit the four-burner lamp as a longitudual coil is required for each burner. *Ginger* had the largest boiler, which by comparison with little more than half the tubing in *Frolic* must have worked very inefficiently. The large variation in heating surface from one boat to another, although foreseen to some extent, is also due to the class weight limit, as after making the hull and the rest of the plant, the balance of the weight has gone into the boiler. It is advisable to leave a small margin, or small additions and alterations to other items have to be accompanied by an operation on the boiler, which is the only place where weight can be easily reduced. Such reductions sometimes have the unexpected result of increasing speed, and I believe a certain exponent of flash steam found that successive boiler reductions gave successive increases in performance. This seems to be a case where results cannot be carried to a logical conclusion. It appears that some boilers are designed with too much heating surface for the combustion space allowed. This was so in the case of *Ginger*, which never made effective use of the original 60 ft. of tube. The coils on the boiler of *Frolic* are widely spaced, except towards the burners, where they are progressively closer together, to avoid burning them badly at the hottest region. The first three turns of each coil are closed together to reduce the temperature of the front coil, which is the point where failure usually takes place. At the steam end of the boilers of *Ginger* and *Frolic*, approximately half the total length is paralleled, feeding into the $\frac{5}{16}$ in. diameter steampipe.

All boilers were made of bright mild seamless tubing, roughly annealed with a flame before coiling. The last two were coiled round a $1\frac{1}{2}$ in. diameter bar by hand, the annealing being necessary to avoid kinking. Joint sleeves and tees are of mild steel, all joints being



"Frolic"—Part sectional elevations of engine

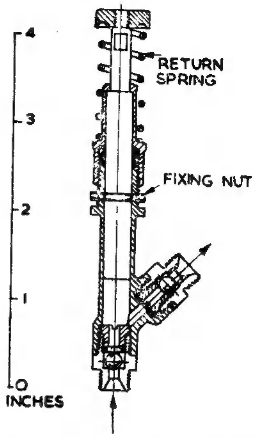
welded. The first two boilers were brazed, and failures were usually due to overheated joints. I have yet to have a failure of a welded joint. The life of a boiler is about two seasons, if care is used to leave it dry when not in use. Pitting from rust inside can cause more deterioration than the scaling which occurs from heat during use.

The casings of the first two boilers for twin-jet firing were rectangular in section (6 in. wide by 3 in. deep). This section was changed in the two later boilers to one more efficient from the point of view of weight saving and heat retention. Tinplate was used for the three earlier casings, and soon had a deplorable appearance. The casing for *Frolic* is made of 0.015 in. stainless steel which, although a little heavier, is much more durable. This casing is lined on the bottom half only with $\frac{1}{16}$-in. asbestos, the rest of the surface being left uninsulated, due to the difficulty of retaining a lining on the top half, and to weight limitations.

Air Intake. All casings were designed to take the air into the lamp and boiler from the top and sides, the quantity being adjusted by flaps or cowls at the front and rear of the boiler. It was found with *Frolic* that a very large cowl, which might better be described as a scoop, was required at the intake for the boat to reach a maximum of 50 m.p.h. With this arrangement, the bottom boiler coil was very sooty, indicating that the bottom burner was starved of air. This condition had also been apparent on the boiler of *Ginger*, and early in 1952 a radical change in the air intake of *Frolic* was made. The shaped nose of the hull, above the deckline, which faired into the lines of the boiler and lamp casing, was removed. The blowlamp flame tubes were mounted on a skeleton, and an experimental tinplate scoop was fitted, with a forward facing air intake, $6\frac{1}{4}$ in. × $1\frac{1}{8}$ in., on the centre-line of the boiler and lamp. I had no particular hopes for this arrangement before it was tried, the maximum advantage expected being better combustion on the bottom burner, and decreased air resistance, due to removing the scoop previously used. I anticipated that a gain of perhaps 5 m.p.h. if all went well, would be reasonable, but that there was a risk of the lamps being blown right out, making the experiment a failure.

Only one run was taken with this experimental scoop. After the first lap every second lap was "clocked" and the speeds taken were 57, 61, 65, 68 and it was thought 71. This last was doubtful, due to quantities of water on me and the watch, and I was checking another lap when the boat "flipped." Damage was done to the silencer (torn off), boiler casing and mountings (lifted by water pressure from beneath), and to the petrol tank, crushed by water pressure). The front plane of dural sheet, which forms the two front skids, was also torn off.

The experiment was pronounced a success and is the only occasion on which a gain of more than 3 or 4 m.p.h. has been made immediately from an alteration. A permanent air scoop was made from 0.009 in. stainless steel, incorporating a hinged section, which is opened forwards to allow more air to the lamp when starting the boat, and a series of flaps of different sizes which can be attached to this section to throttle the aperture which remains when it is closed. The hinged section is left open when the boat gets away and is closed by air resistance at approximately 25 m.p.h.

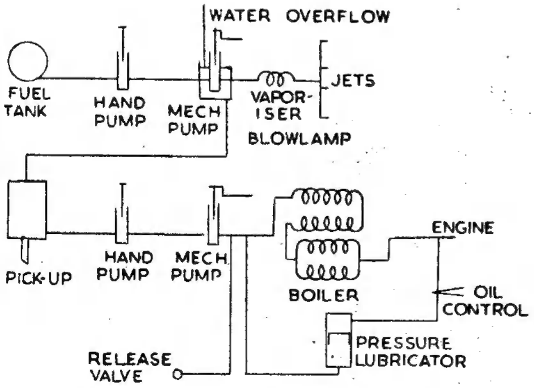


Starting pump—"Frolic"

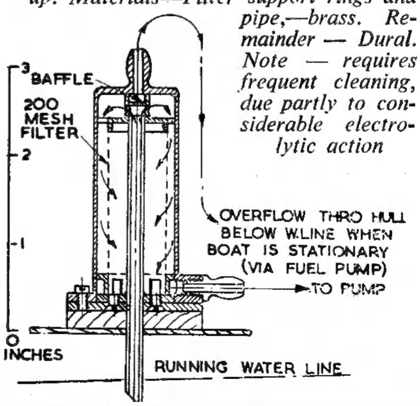
Boiler Mounting

The boiler, casing, lamp and air intake scoop on *Frolic* in its latest form are built as a unit, which is mounted in the hull on four plates, attached to the top and deck stringers. A 4-B.A. screw at each point passes through the casing flanges into a nut brazed to the mounting plate. Removal of this unit is easy, and has to be done before the engine is removed, first disconnecting three pipes (steam, water, and fuel). Deck mounting is preferred, because apart from increased accessibility it has the advantage of adding torsional rigidity to the hull.

(*To be continued*)



Schematic plumbing diagram—"Frolic"



"Frolic"—Water tank, filter and pick-up. Materials—Filter support rings and pipe,—brass. Remainder — Dural. Note — requires frequent cleaning, due partly to considerable electrolytic action

READERS' LETTERS

Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

A GEARING PROBLEM

DEAR SIR,—It seems to me that the layout suggested in reply to J.B.'s query in the June 25th issue, could be considerably simplified by using a *two*-start worm on the first motion shaft and gearing to this a 19-tooth wormwheel on one side giving 8 r.p.m., and a 76 tooth wormwheel on the other giving 2 r.p.m. This would, of course, result in the two shafts rotating in opposite directions, but your querist does not mention whether this is of any importance. Presuming it is not, this layout substitutes one additional wormwheel, and its shaft and bearings, and abolishes four gears and two shafts and their bearings. If both shafts must rotate in the same direction, the simplest arrangement would be l.h. and r.h. worms in tandem, one gearing with each wormwheel.

Yours faithfully,

Rustington. K. N. HARRIS.

UTILITY STEAM ENGINES

DEAR SIR,—I am very glad to see Mr. Westbury has started his articles on the above subject again, and what a start! A lovely little model; I quite appreciate that he cannot fill THE MODEL ENGINEER with articles on steam engines, but when he does put something on paper it is very much to the point, and gives us a shaking up in our think-boxes. Here is one who is looking forward to further instalments.

I am also looking forward to the time when you publish the drawing for the open-type petrol or gas engine, as mentioned in an earlier issue, so that we can do away with the electric motor for running the lathe and have a companion instead of a pussy cat!

Yours faithfully,

Rossendale. R. BOOTH.

ACCURACY IN MODELLING

DEAR SIR,—As a reader of THE MODEL ENGINEER of many years' standing, I am frequently instructed not to use cheese-head screws, to be meticulous in my painting of models, making all these true to prototype, and generally speaking, to aim at a general improvement in accuracy.

I am afraid, however, that the July 2nd issue of THE MODEL ENGINEER itself is "well off the beam."

In the article by "Northerner," there are three vertical steam engine models, each of which is described as a marine engine. The first, a tandem engine, has a pulley on the crankshaft extension, and presumably drives a second line or propeller-shaft by belt. The second engine, a compound, has a large flywheel and is like the first, not fitted with reversing gear. The third engine was seen as a lighting set on numerous ships, but it also cannot be termed a marine engine, unless it is a steam-electric propulsion job.

I mention that to be rightly termed a marine engine, no flywheel should be fitted, the drive should be through a thrust-block, and in most cases reversing gear should be fitted.

In conclusion, many thanks for years of pleasure and instruction from THE MODEL ENGINEER.

Yours faithfully,

"CHEESE HEAD"

SUPPLY DIFFICULTIES

DEAR SIR,—I heartily agree with the sentiments expressed by "Simple Soul" in your issue of July 2nd, 1953.

Sometime ago I required a well-known type of lathe-tool, which had frequently been recommended by contributors to your journal. I wrote to the manufacturers, regular advertisers, who informed me that they were unable to supply direct, but gave me the names of three distributors: Firm "A" 3½ miles from my residence, Firms "B" and "C" 10 miles away.

I called on "A" and saw the senior assistant who did not even know what the tool was. I then wrote to "B" who replied that they did not stock the item in question, no offer to obtain same.

Next move was to telephone "C," who did not stock the tool, but offered to obtain it; they had no idea of the price nor the time required for delivery, but would inquire and let me know.

Having heard nothing more after about a month, I again wrote to the manufacturers, explaining the position, to which letter I received no reply. However, the firm evidently wrote to their distributors, as I received a letter from firm "C," saying if I let them know details of my requirement they would obtain it.

Eventually after about two months, I obtained the tool required, having actually spent more in postage, telephone calls and petrol than the cost of the tool, to say nothing of wasted time.

Just recently I again wanted an item made by the same firm, and saw the manager of firm "A," who stated they did not stock the item, but he *might* be able to obtain as small a quantity as one gross, but could not state the price, as the latest price list he had, was four or five years old.

In future when I see an article advertised which can be obtained from local distributors, I shall ignore it.

Yours faithfully,

Exmouth. A.D.S.

MODEL POWER BOAT PONDS

DEAR SIR,—In connection with the article by "Meridian" in the issue of THE MODEL ENGINEER dated June 25th, regarding suitable water for model boating, may I point out that I heartily endorse the view regarding the lack of same in N.W. London.

Whitestone pond, at the top of Hampstead Heath, is the only one I know in this area with cement bottom and sides, and consequent lack of weed. The other ponds on this heath are useless for power boats. I personally have to travel nine miles from Harrow to use this pond, and without my car it would not be possible with a 4 ft. boat.

The "Welsh Harp" is not suitable, as one cannot get all round it.

The expense these days is the local authorities' snag, no doubt, but it would be an attraction both to visitors without models and with, if another lake, say at Hendon, or Finchley, could be sponsored.

How about a petition?

Yours faithfully,

Hatch End. A. C. UPSON

Model Power Boat News

BY MERIDIAN

WALLASEY AND VICTORIA REGATTAS

NORTHERN model power boat exponents have fewer opportunities to compete in regattas than their Southern colleagues, unless they are able to travel long distances complete with boats.

This does not mean, however, that their enthusiasm is in any way diminished, and this was amply demonstrated at the recent regatta held by the Wallasey M.P.B. & Y. Club. Many entries of all types of boats made the regatta very interesting, particularly as some of the craft present had never made an appearance further south.

Among the steering boats were several of notable interest, including the fine launch by F. Waterton (Altrincham), fitted with the 6-cylinder petrol engine described recently in THE MODEL ENGINEER. A coal-fired tug by F. Wright (Crosby) also created attention, and an unusual model was the nicely-made lifeboat, complete with much detail, by K. Turner (Altrincham).

Home club members were successful in the Steering Competition, taking all three places. The winner was W. Halligan's steam launch *Margaret*, and ■ tie for second place resulted in J. Hardman and W. Davies having an extra run. The former competitor scored a bull on this re-run to make certain of second place.

There were races for all classes of hydroplanes on the programme and of these the best supported were the Class "A" and "C" events. In the latter race several competitors made their best runs of the season. C. G. Stanworth (Bournville), with *Meteor* 4, recorded 52.9 m.p.h. R. Mitchell (Runcorn) achieved over 49 m.p.h. with both *Gamma II* and *Gamma III*, and J. Jones (Maghull) made ■ very creditable run at 44.4 m.p.h. with *Mambo*.

The 30 c.c. race produced ■ good entry, including three from the Altrincham Club. One of this club's entires was ■ new 30 c.c. "split-single" two-stroke engined craft by D. Innes, who will be well remembered for his *Satellite* series of 15 c.c. boats. The new engine sounded nice, but appeared to be somewhat overloaded with the twin propellers at present used.

J. Benson's *Orthon* (Blackheath), after a slow first lap, speeded up to such good effect that the 5-lap speed was 57.7 m.p.h. and W. Morris (Bournville) also recorded over 50 m.p.h. with *Ned Kelly*.

Results

Nomination Event

(1) H. Wraith (Altrincham): 2.6 per cent. error.

Steering Competition

(1) W. Halligan (Wallasey), *Margaret*: 5 points.

(2) J. Hardman (Wallasey), *Lucania*: 3 points.

500 yd. Class "D" Race

(1) E. Hampson (Maghull), *Skippy*: 30.71 m.p.h.

500 yd. "C" Restricted Race

(1) W. Morris (Bournville), *BV*3: 41.74 m.p.h.

500 yd. Class "C" Race

(1) C. G. Stanworth (Bournville), *Meteor IV*: 52.99 m.p.h.

(2) R. Mitchell (Runcorn), *Gamma III*: 49.65 m.p.h.

500 yd. Class "B" Race

(1) R. Mitchell (Runcorn), *Beta IV* 46.7 m.p.h.

500 yd. Class "A" Race

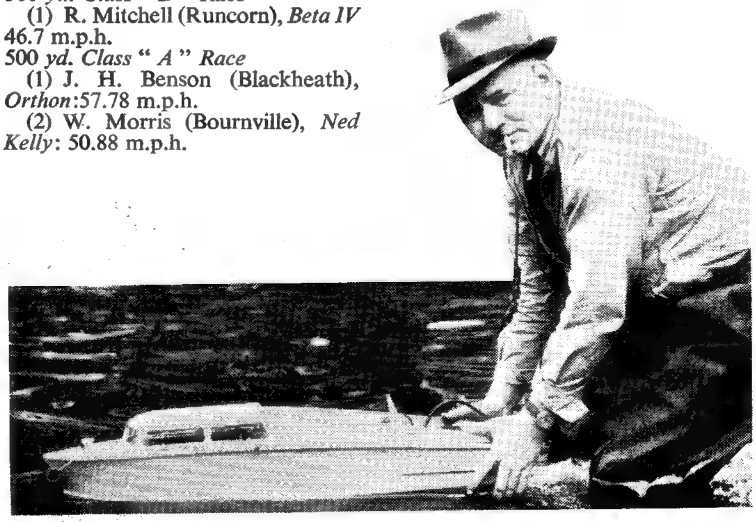
(1) J. H. Benson (Blackheath), *Orthon*:57.78 m.p.h.

(2) W. Morris (Bournville), *Ned Kelly*: 50.88 m.p.h.

A large entry of boats made the Victoria M.S.C. event seem like a miniature Grand Regatta! The entry was particularly heavy in the Steering and Nomination events —no less than 46 different boats taking part. Newcomers to competition work were several cruising boats from the Forest Gate club. This club has made much progress since being formed about two years ago.

A popular winner in the Steering competition was W. Blaney (Victoria) with his spirit-fired *Lil' Man*. Three competitors each scored 13 points, and on the re-run, Mr. Blaney made no mistake, scoring an inner against A. Clay (Blackheath) with *Elizabeth*, who scored an outer, while S. Dearling (Blackheath) who was the other competitor involved in the tie, missed the target altogether.

Speeds were good in the circular-course racing events, except in Class "B," where the only competitor to complete the course was R. Cluse (Orpington) with *Crack o' Dawn II*. K. Hyder (St. Albans) put up one of his best speeds to date in the "C" Restricted race, with



J. F. Croll (St. Albans) with his petrol-engined launch, photographed by E. Clark

J. Pinchin (Blackheath) starting "Barracuda" at Victoria Park. Photo by E. Clark

Slipper 4, which recorded 57.2 m.p.h. in winning the event.

In the Class "A" race, all competitors returned a time with their respective boats, an achievement worthy of mention, which makes a race so much more interesting than those where capsizes are frequent. J. Benson's *Orthon*, however, flipped at high speed on the first run, and on the second run was considerably slower. E. Clark (Victoria), with *Gordon* 2, was the eventual winner, recording 55 m.p.h. for the 500 yd.

Results

80 *yd. Nomination Race*

(1) J. F. Croll (St. Albans): error 0.3 sec.

(2) Beard (W. London): error 0.6 sec.

(3) J. Slender (Welling), *Sarah Ann*: error 0.9 sec.

500 *yd. "C" Restricted Race*

(1) K. Hyder (St. Albans), *Slipper* 4: 57.2 m.p.h.

(2) L. Pinder (S. London), *Rednip* 7: 55.28 m.p.h.

(3) W. Everitt (Victoria), *Nan*: 52.45 m.p.h.

500 *yd. Class "C" Race*

(1) C. G. Stanworth (Bournville), *Meteor IV*: 44.27 m.p.h.

(2) C. E. Stanworth (Bournville), *May II*: 35.51 m.p.h.

(3) E. Woodley (Victoria): 33.42 m.p.h.

Steering Competition

(1) W. Blaney (Victoria), *Lil' Man*: 13 points + 3.

(2) A. Clay (Blackheath), *Elizabeth* 13 points + 1.

(3) S. Dearling (Blackheath), *Maj* 13 points + 0.

500 *yd. Class "B" Race*

(1) R. Cluse (Orpington), *Crack o' Dawn II*: 24.44 m.p.h.

(No others completed)

500 *yd. Class "A" Race*

(1) E. Clark (Victoria), *Gordon* 2: 55.74 m.p.h.

(2) J. Benson (Blackheath), *Orthon* 51.91 m.p.h.

(3) J. Innocent (Victoria), *Betty*: 51.14 m.ph..

Power Boat Waters—No. 1, Victoria Park

One of the best known power boat lakes in the country is that situated in Victoria Park, London E.9. For long years past, this lake has been the scene of many important regattas. Originally, it was an open-air bathing lake, and consequently rather deep towards the centre. Various diving platforms projected at intervals like miniature Southend piers, and constituted obstacles to which free-running boats were attracted as if by a magnet !

A few years prior to the war, the L.C.C. completely reconstructed the lake, making three from the original long one, and also reducing the depth. Thus, at present the boating lake is a fine stretch of water over 100 yd. long by about 60 yd. wide, and two smaller pools are available for children's use.

The boating lake has a concrete bottom, and is of even depth suitable for wading. For anchoring the tripod for circular-course racing, there are eye-bolts sunk into the concrete in several different positions.

The lake is situated in the eastern side of the park, and the nearest entrance is the St. Mark's Church gate. From here the lake is but a few minutes' walk. There are two bus services near to this entrance: No. 208 from Poplar High Street, and No. 8A, which has a terminus at Old Ford. If the latter bus is used, a few minutes' walk from Old Ford brings one to a side gate of the park near an atheletics track, and the lake is situated at the end of this track.

Now just a word about the Victoria M.S.C. This club celebrates its 50th anniversary next year, and ranks as one of the oldest model power boat clubs in the country. The membership is large, and many enthusiasts who have no club in their own district are members of Victoria. The facilities offered by the club include a club-house and enclosure, situated but a few yards from the lake.

The facilities for circular-course racing are particularly good (apart from some backwash from the vertical banks), and many well-known speed merchants—both past and present, have been members of the Victoria Model Steamboat Club.

E. Clark (Victoria) preparing his "A" class boat, "Gordon 2"

IN THE WORKSHOP

BY DUPLEX

LINEAR ENGRAVING IN THE LATHE

WHEN cutting the graduation lines on small components, such as the indexes fitted to lathe feedscrews or scales serving as depthing gauges for drilling machines, it will be found that this work can

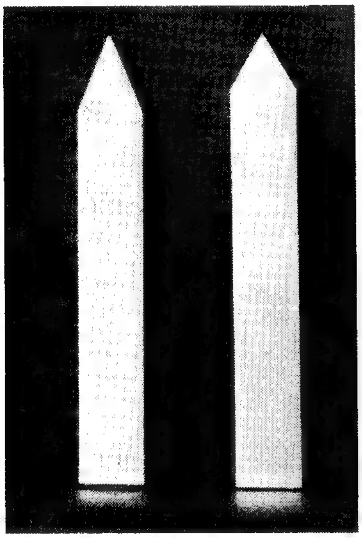


Fig. 1. Engraving tools with 45 deg. and 60 deg. points

quite well be accurately done in the lathe and is then often superior to some commercial counterparts.

As the accompanying illustrations show, a great variety of engraving can be undertaken, and this includes lining cylindrical work radially on its face, as well as marking the outer surface with graduation lines running in either the axial or the circumferential direction.

Engraving Tools

It is of some importance that the tools used should be of the correct form in order to obtain regular and cleanly cut lines. Where the work is of small size, the lines cut should be correspondingly narrow, but at the same time, the graduations should be deep enough to give a clear marking that will show up clearly against the background.

A V-pointed tool having an included angle at the tip equal to 45 deg. will cut fine, deep lines, and

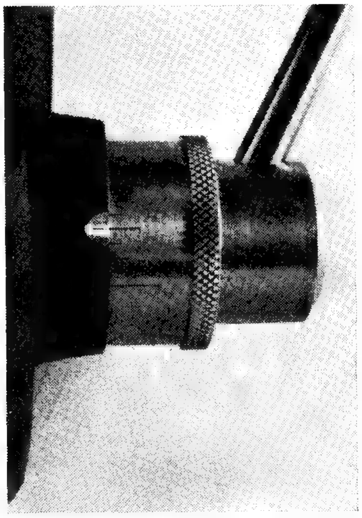


Fig. 2. A drilling machine depthing gauge

for larger work either the depth of cut can be increased to give a broader marking, or the tool angle may be increased to 60 deg. to obtain the same appearance. When engraving steel parts, there is a danger of breaking off the extreme tip of a finely pointed tool; however, this can be largely overcome by using tools made of good quality high-speed steel and, in addition, the tip can be strengthened by honing a narrow flat on the forward cutting edge, but if the honing is excessive the tool will cut an indefinite, shallow line of poor appearance. To check any tendency for the tool to dig-in when cutting either brass or steel, the upper surface of the tool should be kept flat and given no top rake. Furthermore, the clearance at the side faces of the tool should be restricted to some 5 deg. so as not to weaken the point.

Tool Setting

When cutting along the circumference of cylindrical work, the tool is, of course, set at lathe centre height, and for radial engraving, or for cutting parallel to the axial line, the tool is mounted on its side and packed up to centre height.

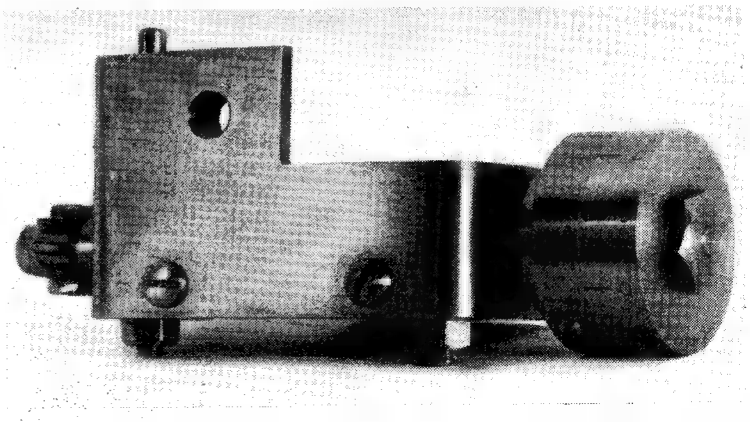


Fig. 3. An engraved drum index

That is to say, a $\frac{1}{4}$ in. square tool when on its side will need $\frac{1}{8}$ in. of additional packing to set the point correctly and, at the same time, the tool is mounted with its long axis at right-angles to the work face in order to keep the top rake angle at zero, and also to afford the necessary clearance at the front cutting edge.

Axial Engraving

In the first place, the exact length of the graduation lines must be decided, and this is, perhaps, best done by copying a piece of work where the lines look correctly proportioned and can be easily read. Other ways are to measure the lengths of the graduations inscribed on a rule, or to make a scale drawing of the finished work.

Examples of engraving in line with the lathe axis are shown in Figs. 2 and 3; the first is a cylindrical depthing scale, with its register line, fitted to a drilling machine, and the second represents a revolving index of the drum type.

Tool Mounting

In both instances, the work is mounted in the mandrel chuck and the index lines are cut either by moving the saddle along the bed or by actuating the top-slide of the lathe. For this purpose, the V-tool is mounted on its side in the tool-holder and is set at centre height. This operation has been described in detail in a previous article and, briefly, it consists in indexing the work from a change-wheel attached to the tail of the mandrel, or from a gear train mounted on the quadrant, or a dividing head may be used.

The length of the lines cut is controlled from the leadscrew index, and the markings are incised to a depth of some 4-thou. of-an-inch by feeding the cross-slide inwards. On completion of the engraving operation, the burrs set up at the far end of the lines are broken off with a piece of brass strip, and the indexed surface is finished by applying a dead-smooth file to the revolving work. A rather better way, perhaps, of ensuring a good finish is to cut the lines an extra one-thou. of-an-inch deep and then to take a light finishing cut over the surface. To make the lines stand out clearly against their background, all that is usually needed is to rub the work surface with a dirty finger, and the deep but narrow cuts will then retain the dark-coloured deposit.

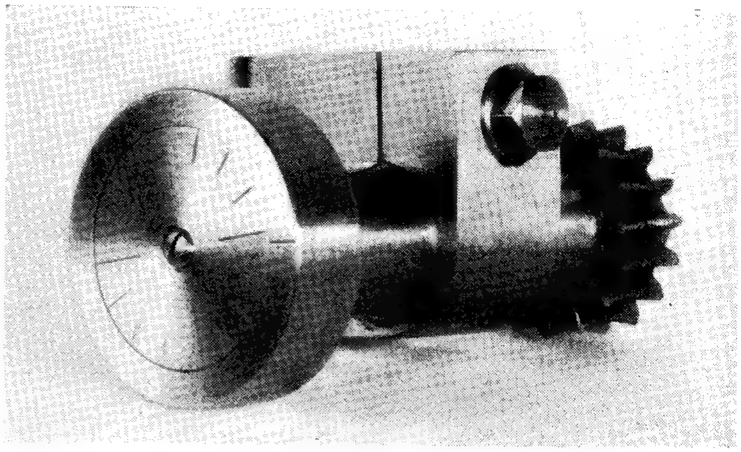


Fig. 4. Radial engraving on a thread indicator

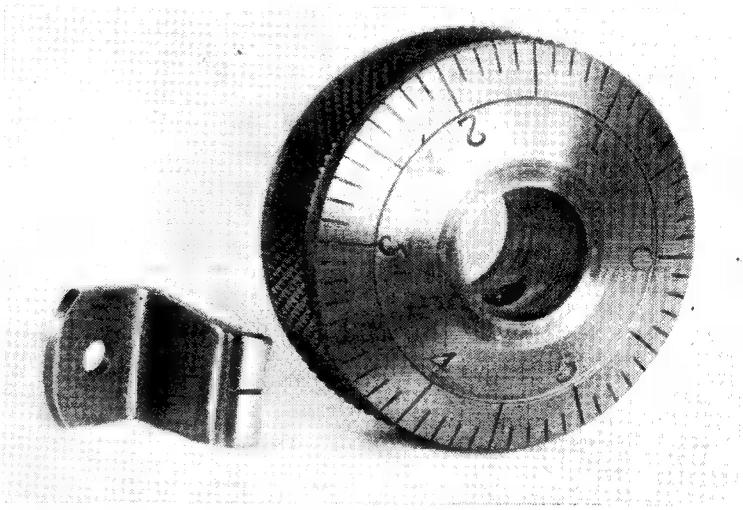


Fig. 5. A coned index collar with its register

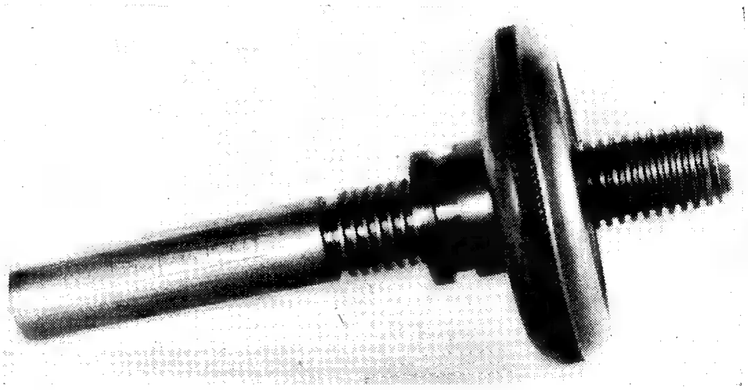


Fig. 6. A graduated tailstock barrel

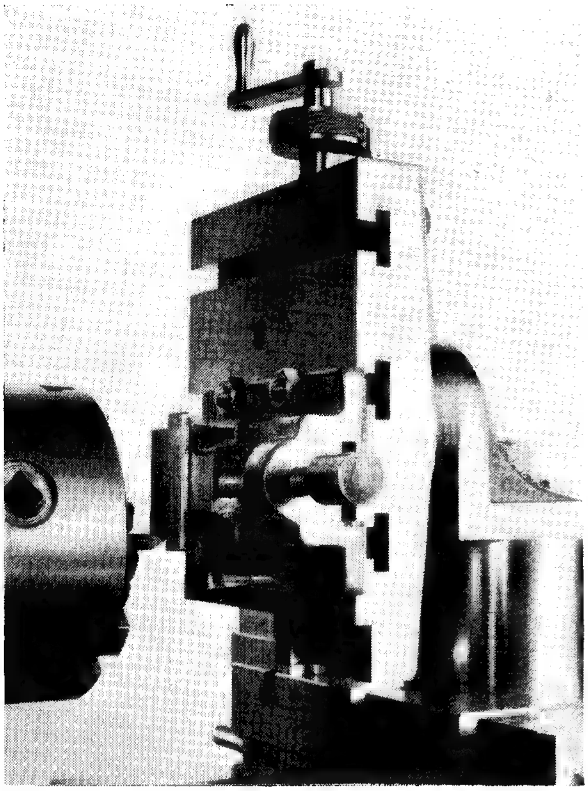


Fig. 7. *Method of engraving a linear scale*

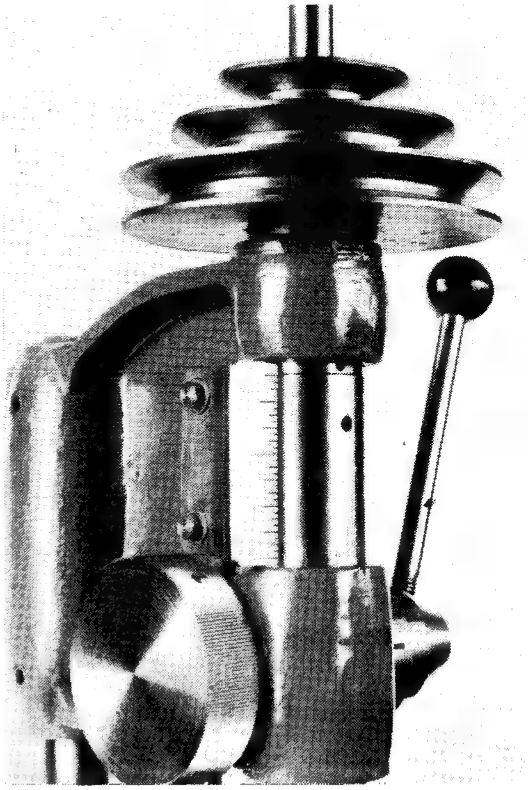


Fig. 8. *A drilling machine linear depthing scale*

The stationary register lines seen in the photographs were engraved in the same way as the indexes themselves. In these and in all similar machining operations, any of the lathe slides not in actual use should be securely locked.

Radial Work

The photograph of the thread indicator in Fig. 4 illustrates an example of radial engraving. Here, the tool is again set on its side at centre height, but the cutting edge faces inwards.

The method of feeding is, however, rather different, as the tool is fed inwards by means of the cross-slide and the feedscrew index serves as a guide for cutting the lines to length.

When it comes to engraving the register line on the outer fixed collar, the tool is turned over and the direction of cut is then outwards from the centre.

A variation of this method is illustrated in Fig. 5 which represents an index collar with a coned face. To machine this surface, the top slide is set over to the required angle and the cutting of the index lines is carried out without altering the setting of the slide, for this is essential if the graduations are to be formed to the same depth and width throughout their length.

Engraving Along the Circumference

When, for example, graduating the tailstock barrel, the engraving is done in the manner illustrated

(*Continued on page* 136)

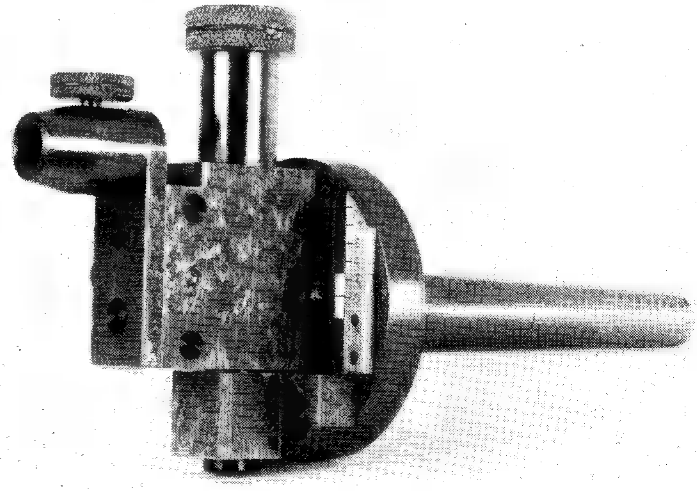


Fig. 9. *A small scale fitted to a measuring appliance*

BRITISH CRAMPTON LOCOMOTIVES

By E. W. TWINING

PART 5

FOLLOWING up the intention indicated in his last article, the writer gives here drawings traced from the Beever engravings, showing the whole of the constructional details of Crampton's fine engine, the *Liverpool*. These, with the exception of [redacted] half plan, are wholly sectional views: Fig. 10, a longitudinal on the centre-line, Fig. 11 sections at four different points across the engine and Fig. 12, [redacted] half-plan with the cylinder, driving wheel and firebox in section with the boiler barrel removed, to show the frame cross members, and below this [redacted] general plan of the complete engine.

In the writer's last article, where reference was made to the engraver, W. A. Beever, mention should have been made of the draughtsman, who prepared the drawings from which the plates were engraved. He was David C. Glen, who probably did the drawings directly upon the copper plates, ready for engraving. The external view, that is to say the side elevation, published in Tredgold's work, which in certain respects differs from all the other plates was, although drawn by another man, also engraved by Beever and it seems somewhat curious that Beever did not notice and call attention to the discrepancies. In making the shaded elevation, which was the subject of Fig. 8, the present writer has put in all the

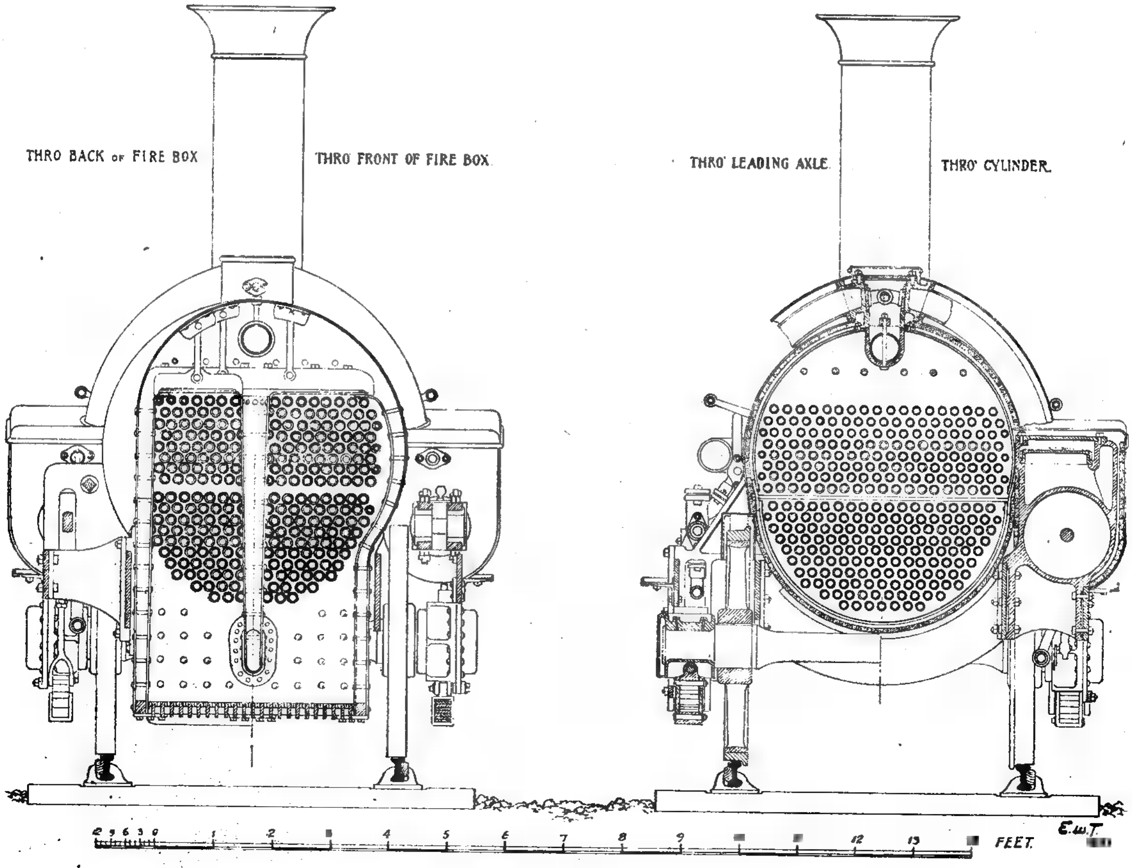


Fig. 11. Four cross-sections of Crampton's [redacted] Liverpool"

necessary corrections to make it agree with Glen's drawings, which are obviously accurate in all mechanical details and in which respect the original elevation is not.

Advances

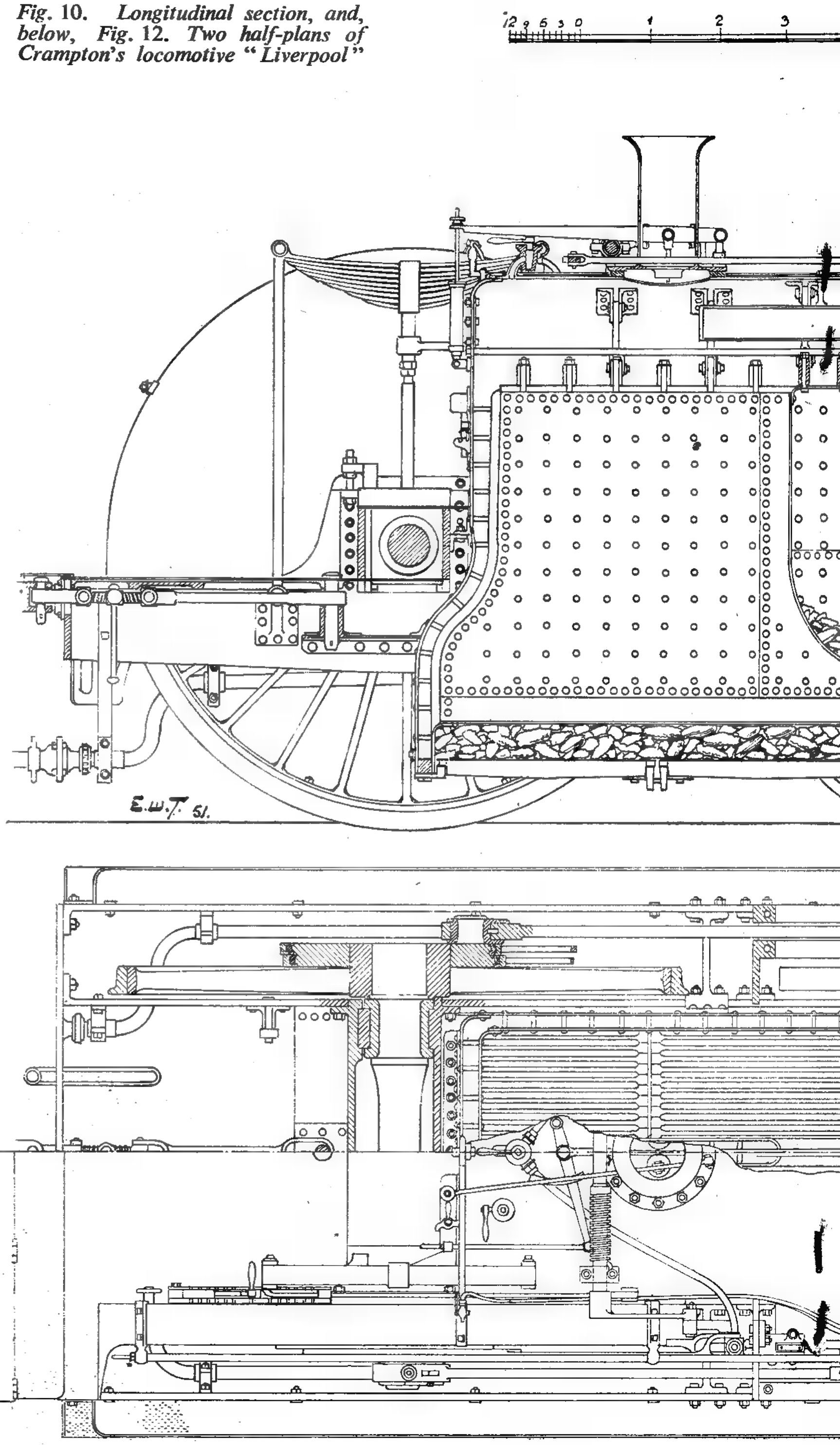
In critically examining these drawings the thing which struck the writer, in the course of tracing, was the wonderful advances which had been made in locomotive design by the year 1848. These are evidenced also in the engravings of Gooch's broad gauge *Iron Duke* of the previous year; which engravings are also to be found in Tredgold. Many of the mechanical details would not be out-of-date if they were found in modern engines and indeed some of them have remained unchanged even to the present day. In the *Liverpool* there were certain features, the designs of which obviously owe their origin to Daniel Gooch, and to the influence which Crampton's training under Gooch had upon his later work. The smokebox dampers, a series of shutters, like a venetian blind, are a case in point. On the Great Western these, in a few years became obsolete, being superseded by dampers on an ashpan and, though this is doubtful, may have been altered on *Liverpool*; but in 1848 the dampers were exactly alike in both engines. *Liverpool* had no ashpan but *Iron Duke* had, even when first built, in 1847, although the front of the pan was open. In 1851, the broad gauge *Lord of the Isles* had both smokebox and ashpan dampers of which latter there were two, but the smokebox shutters were shortly afterwards removed.

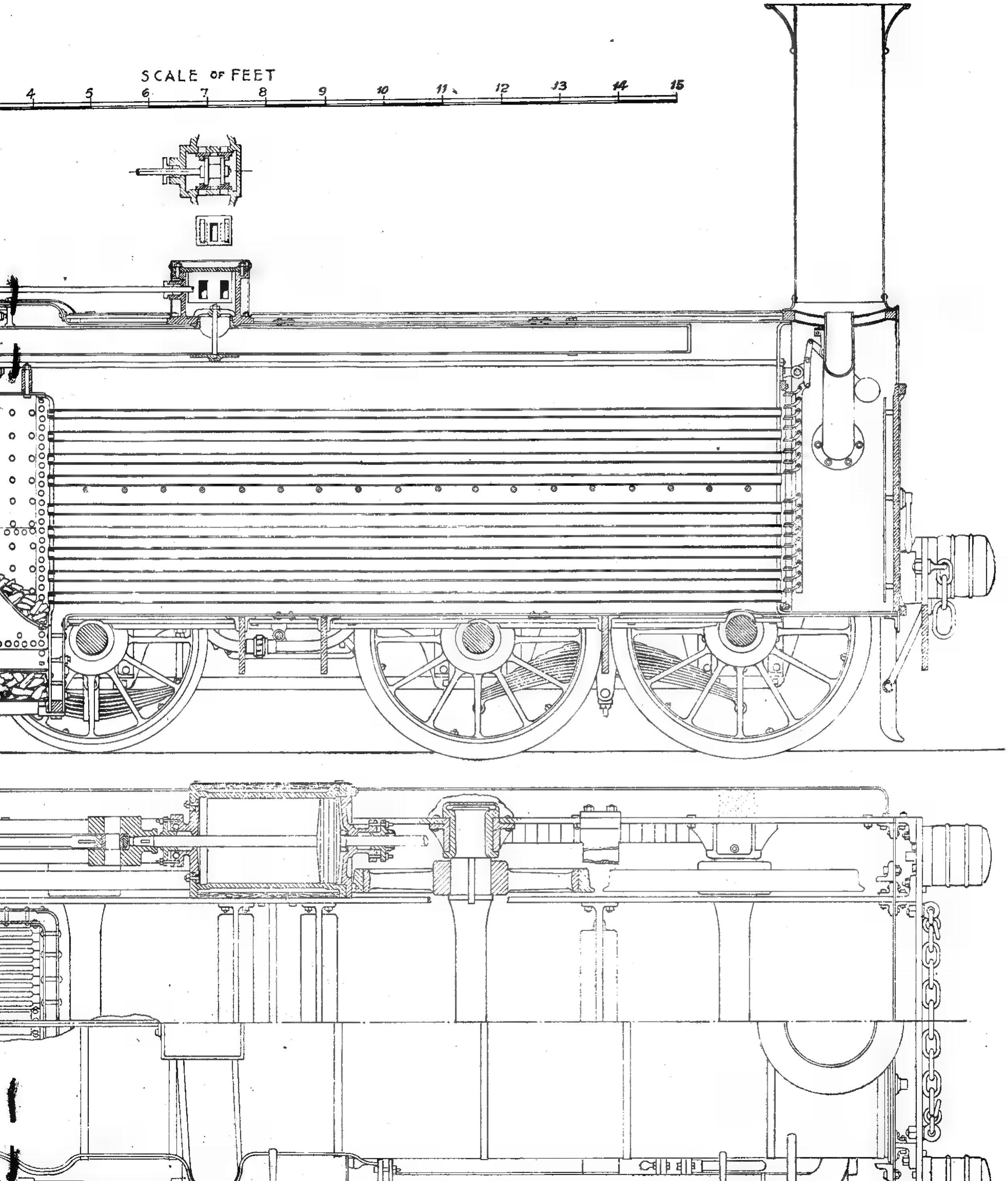
Unusual Design

The boiler in the *Liverpool* was a most unusual piece of design and must have presented a difficult constructional job to the boiler shop of those days. The firebox had, of course, to be sufficiently narrow to fit between the driving wheels at the back and, at the front, wide enough to take, into the tubeplate, all the flue tubes passing through the double-segmental barrel, which was of much larger diameter than the normal firebox width; so the firebox side plates, both inner and outer, were made to bulge outwards on both sides, as may be seen in the plan, Fig. 12, and by comparing the two cross-sections through the firebox, in Fig. 11.

As the drawings show, there was, in the firebox a deep midfeather, which added very considerably to the heating surface, and very efficient

Fig. 10. Longitudinal section, and, below, Fig. 12. Two half-plans of Crampton's locomotive "Liverpool"




SCALE OF FEET
4 5 6 7 8 9 10 11 12 13 14 15

surface, too. The writer has always been a great admirer of Gooch's eight-feet singles, all of which, when first built, had firebox midfeathers, but whereas Gooch's were placed across the box, and were closed at top and bottom, Crampton's was arranged longitudinally, was closed at the bottom only and was open at the top. This gave much more free circulation of water and far greater freedom for the rising of steam bubbles. It is true that the dividing of the firebox into two compartments thus, involved the fitting of two firing holes and doors, but the fireman was able to see the whole of his fire, whereas in Gooch's firebox the front compartment was completely hidden and the state of the fire in it could only be judged by the red illumination of the tube-plate and the firebox sides visible above the midfeather. Firing of the front compartment had to be done by shovelling the coke (the fuel then used) over the midfeather, but how it was evenly distributed and raked over is a mystery. However, it is not the broad gauge engines which we are dealing with, but the narrow-gauge monster *Liverpool*, and the comparative design of fireboxes is only raised to give some idea of the cleverness of T. R. Crampton as a locomotive designer and engineer.

Large Eccentrics

There is no need to refer to the whole of the details of this famous engine; to the model locomotive engineer they will be obvious from the drawings, but there is one more feature of the design which may well be, or ought to be mentioned, and it is one which unfortunately casts a little shadow over Crampton's brilliant genius. In the last article reference was made to his patented large eccentrics, having a sheave diameter of 2 ft. 9 in. These were shown in the side elevation, Fig. 8, and are also in the accompanying plan, Fig. 12, where the sheaves and straps are drawn in section. It is difficult to understand how Crampton could have overlooked the enormous amount of friction which must have been set up by rubbing surfaces, each having a circumferential length of 8.63 ft. Francis Trevithick and Allan adopted them in one or two engines at Crewe; but they gave endless trouble, through overheating, and they possibly did so in *Liverpool.* In any case, Crewe quickly abandoned them. It is not, of course, difficult to understand why they were adopted for *Liverpool;* they did away with the return crank and enabled the whole of the valve-gear to be put inside of the centre-line of the cylinder and motion; but the whole arrangement is not to be compared with the gear provided for the Crewe-built *Courier* for neatness, lower cost of maintenance and general efficiency.

The regulator was double; that is to say there were two valves, sliding on slightly inclined faces, one for each cylinder, in a square box on the boiler barrel. In the longitudinal section, Fig. 10, only one of the port faces is shown, but above the box the writer has added one valve, which was little more than a flat plate, having a single rectangular port cut through it. The position in which this valve is drawn was that taken up when the regulator was closed. Both valves were operated by one push-and-pull rod and were moved by a cross piece on the end of the rod, in the manner shown in the small sectional plan, which has also been added by the writer.

LINEAR ENGRAVING IN THE LATHE

(*Continued from page* 132)

in Fig. 6. The method of carrying out this work in the lathe itself was described in " In the Workshop," Vol. III and need not be repeated, except to say that the tailstock barrel is reversed when mounted in the four-jaw chuck and supported by a female centre gripped in the tailstock casting. The tool is set facing downwards, and the graduations are accurately spaced with the aid of the leadscrew index. The depth of the lines is regulated from the cross-slide feedscrew index, and their length is determined by rotating the mandrel, by means of the backgear, to register marks made at appropriate intervals on the flange of the belt pulley. This work must, however, be accurately and methodically carried out, or the appearance of the tailstock barrel will be marred for all time.

Engraving Linear Scales

So far, the lathe mandrel has been used either for indexing the work or for rotating the component when cutting along the circumference. But for engraving linear scales on flat material, the tool is gripped in the chuck and the work can be held in a machine vice attached to the vertical-slide, as shown in Fig. 7. Two examples of scales made in this way are illustrated in the accompanying photographs. The scale shown in Fig. 8 serves as a depthing gauge for a drilling machine, and the appliance illustrated in Fig. 9 is for mounting in the lathe tailstock to enable the dial test indicator to give a direct reading of the diameter of chuck work being machined; incidentally, the two 12-B.A. screws used to attach the small scale were turned and threaded in the Drummond lathe.

Both the scales illustrated were made from thin steel strip, and the difficulty of mounting them in the vice was got over by leaving surplus material at either end, so that the strip could be attached to a gripping-piece with screws and the scales cut to length after engraving. For this kind of work the tool is made from round material and the V-point is fashioned in the usual way. After the lathe mandrel has been locked, the tool is adjusted in the chuck so that the cutting face stands vertically. With the tool mounted in the way illustrated, it will be clear that the depth of cut is set from the leadscrew index; the length of the graduations from the cross-slide index, and the spacing of the graduations from the index of the vertical-slide. There is one important point, however, that should be borne in mind, namely, that engraving should start at the top of the scale and be continued downwards. The reason for this is that the feedscrew should be used to raise the weight of the slide and its attachments, for where the slide is fed downwards there will be some uncertainty as to the weight of the slide taking up the backlash between the feedscrew and its nut, and this may lead to irregular spacing of the graduations.

A NEW ADHESIVE

We have recently tried out a new all-purpose adhesive known as "Mistic," which is marketed by Spicers and obtainable from stationers and ironmongers all over the country. It has a rubber latex base, and has all the qualities associated with this medium, including tenacity, quick drying, flexibility and transparency; further, it is non-inflammable and resistant to heat and water. For many purposes in model engineering, not to mention domestic repairs and all kinds of homecraft, this adhesive will be found extremely useful. It is supplied in handy-sized screw-capped plastic tubes, at one shilling per tube.

SMALL HOT-AIR ENGINES

CYNICS have remarked that model engineers never take an interest in anything until it is obsolete. While we do not admit this impeachment, it is a fact that many engines and other machines which have long been forgotten by the professional engineer, still continue to interest model engineers, and that a description or discussion of such objects will often revive or bring to light an unexpected world of interest.

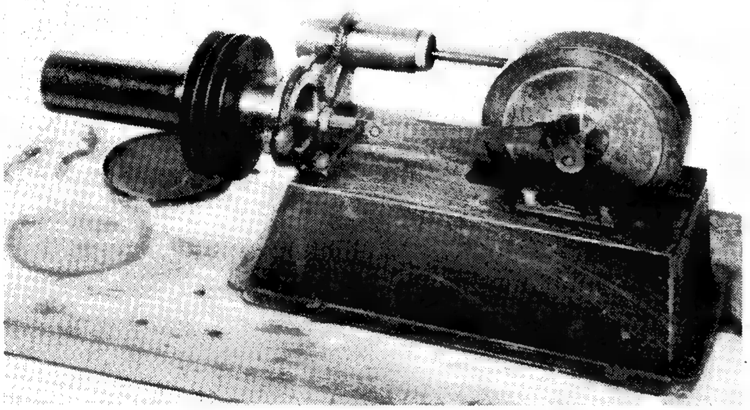
This certainly seems to have been the case with hot-air engines, the subject of which crops up perennially, and the recent article on "Hot Air Engine Mechanism" has evoked a flood of correspondence, much of which was addressed personally to the author: but owing to his death, which occurred before the publication of the article, we have dealt with these letters to the best of our ability, and selected one or two for publication in THE MODEL ENGINEER.

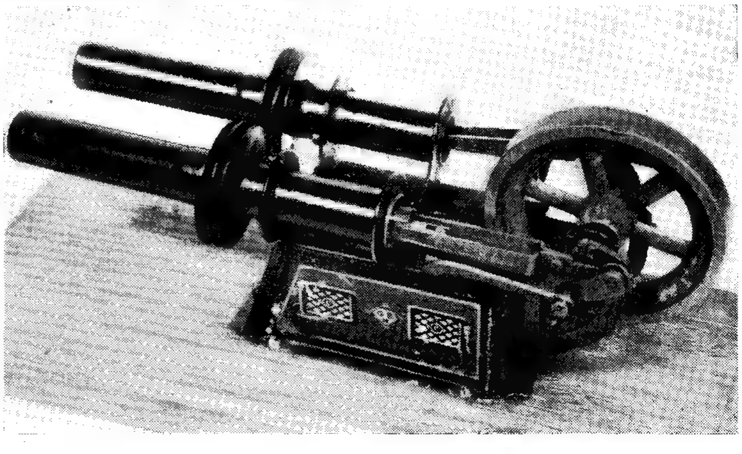
Many of the letters describe old hot-air engines which the writers possess; none of these appears to present any novel features or bring to light any principles with which we are not already familiar. Most of them, indeed, are "toys" of Continental manufacture, such as were very commonly seen in the toy shops at the beginning of the century. They operate on the closed circuit principle, using a displacer to transfer air from the hot end of the working chamber to the cool end. This is driven either by a separate crank or by linkage from the power crank, and timed 90 deg. in advance of the latter. In this respect they follow the general principles invented by the Rev. R. Stirling (father of Patrick Stirling, of locomotive fame), in 1827. Both air-cooled and water-cooled examples have been brought to our notice.

A typical example of the toy engines referred to is shown in the first photograph, which depicts an engine we have had in our possession for many years, having originally found it on a junk barrow in Farringdon Road. This is of the two-crank type, the single-acting power cylinder being connected to the displacer chamber by a short pipe.

A twin-cylinder engine, (See second photograph) which may well have emanated from the same toy factory, was brought for our inspection by Mr. A. Barnes. While the structure of this bears a marked similarity to that of the above specimen, the power and displacer cylinders in this case are in tandem, the displacers being driven by return cranks and bent connecting-rods. The pistons have the displacer-rods working through their centres, and drive the cranks through forked connecting-rods; this motion-work bears some similarity to that of some of the engines which have been described by B.C.J. and other contributors. Both engines have air-cooling fins, and are without any means of heating (in their present form), but can be coaxed into life in a few seconds by applying a spirit-lamp or bunsen-burner.

There is no doubt whatever, that hot-air engines are very fascinating things to watch; they are also very consistent and trouble-free in working, and fairly safe to turn loose with unskilled operators, as there is nothing to burst or explode about them. But the fact must be faced that they have never offered any attraction to the constructor; we know of very few that have been built by amateurs. One reason for this is that they are very imperfectly understood; although their working principles have often been explained in THE MODEL ENGINEER, we find they are still regarded as a mystery, even by experienced engineers. But perhaps an even more important reason is that their low power output in relation to size limits their practical applications as compared with other types of engines. Working on extremely low pressure variations as they necessarily do, they have to be very accurately made and fitted to work at all, especially in small sizes, and in their simple form, it seems practically impossible to improve upon them to any appreciable extent.





A Research MICROSCOPE

by Lawrence H. Sparey

WE are now approaching some of the most interesting work in the whole microscope—the fitting of the slides and the making of the racks and pinions. The vee-slides should be fairly accurate as they come from the machine, but a little hand scraping here and there will be necessary for absolutely smooth action. The male slide should be blued, with engineers' marking blue, and the slide assembled complete with gib-strip. When the slides have been slid together a few times, and dismantled, the high spots on the female slide will be indicated by blue patches, while the high spots on the male slide will show as bright spots. These should be scraped down, very gently, the slide re-assembled, and the process repeated if necessary. Ideally, the surfaces of the slides should be first scraped-up to a special wedge-shaped surface strip, but few amateurs will possess such a thing, although if you have a surface-plate, one may quite easily be made. However, satisfactory results may be had by scraping each surface to its partner.

Continued from page 36 July 9, 1953.

Those not experienced in this kind of work may find a temptation to lap the surfaces together with metal polish; but this should be resisted strongly, as this process tends to make the slides "sticky," so that they tend to adhere, and resist very small movement. This is, in fact, just what happens when lathe slides wear together, and small movements of the feedscrew do not produce a corresponding movement of the slide. The cure is to break up the surface by hand scraping.

The drawing, Fig. 9, together with the photograph, Fig. 10, should convey a complete idea of the body-tube assembly, and the housing for the drawtube pinion. The major part of the work is only turning and screwcutting, but a certain amount of milling and slotting is required. A few words on the screw threads. In instrument work, screw threads are usually made to be a fairly easy fit, one to the other, and components are provided with large flanges which provide for accuracy of alignment. Components should, therefore, screw together quite easily with the fingers.

It will be seen on the drawing that a choice between dural and chromed brass has been given for most items, but that the drawtube (*P*), the bearing cap (*R*), and the bearing-plate (*S*) are indicated in chromed brass. The reason why brass is used for the drawtube (*P*) is two-fold: first, a knurled ring and an annular light-stop must be attached to it, and it is difficult to fix these other than by soldering; secondly, dural is comparatively soft, and would become badly scratched by the continual telescoping of the drawtube within its housing.

The reason why (*R*) and (*S*) are of brass is a purely manufacturing one. These components are very thin, and difficult to hold during machining operations, especially as some fairly heavy milling is required. The only satisfactory method I could hit upon for holding these pieces was to solder them to a large chunk of brass, providing a large holding surface. The components were unsweated when machining was complete.

It will be noted that the top tube sleeve (*L*) is almost completely divided by a ¼-in. slot, except for the thin knurled ring. This slot allows clearance for the rack, and is best done with saw and file. The only other details on Fig. 9 calling for comment are the thin saw-cuts on (*N*) and (*P*). These are necessary to provide a grip on the eye-piece and on the drawtube.

The knobs, shown in Fig. 10, are of the ornamental type—now considered somewhat old-fashioned, and which I, being somewhat old-fashioned myself, prefer to the plain, sheer knobs now in vogue. If elegance in engineering does not interfere with efficiency, I am all for it. However, the knobs of your own microscope may follow your hearts' desire, and I hope that a few variations will be seen. I have never promised dire failure if my own designs are not followed to the letter.

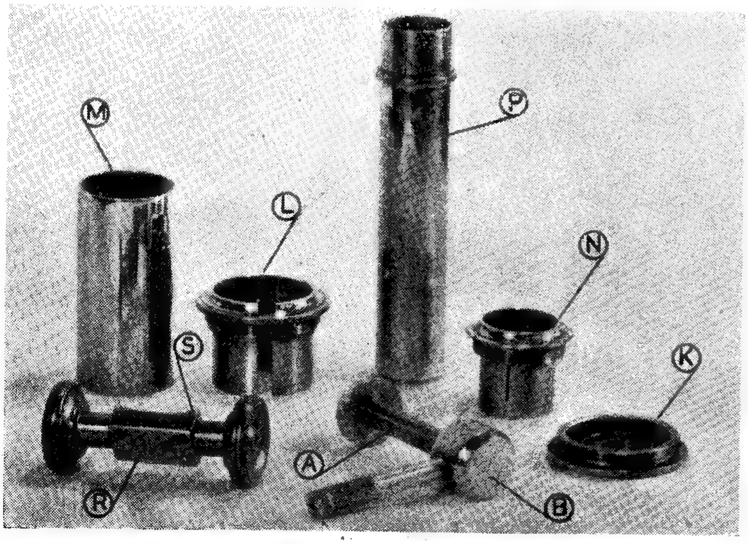


Fig. 10. Some of the microscope parts.—(A) locking bolt, (B) locking lever, (L) top tube sleeve, (M) racking drawtube, (N) drawtube sleeve, (P) drawtube, (R) bearing cap, (S) bearing plate

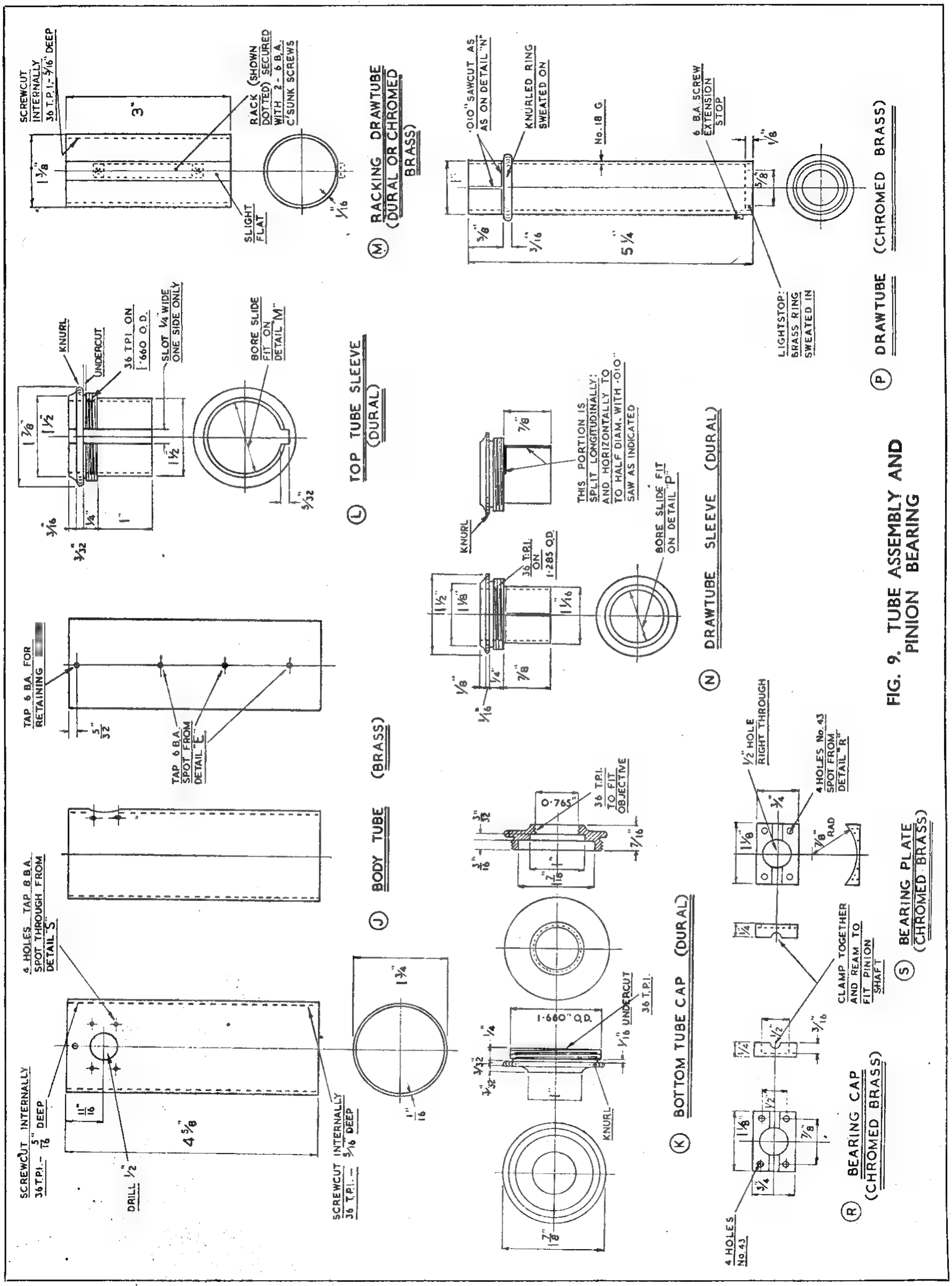
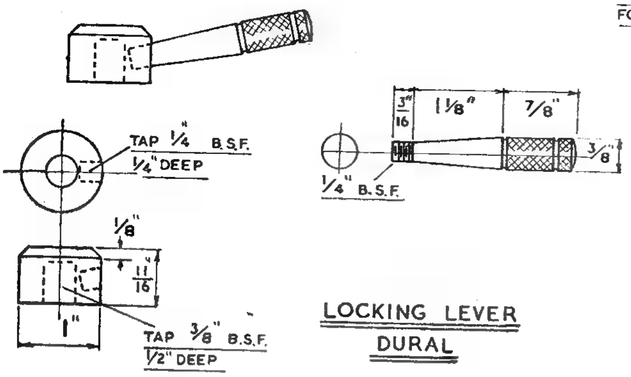
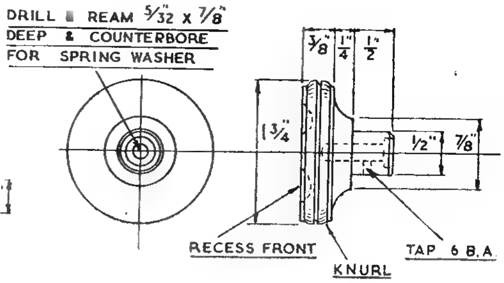


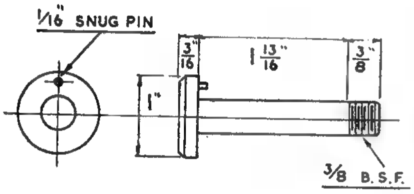
FIG. 9. TUBE ASSEMBLY AND PINION BEARING



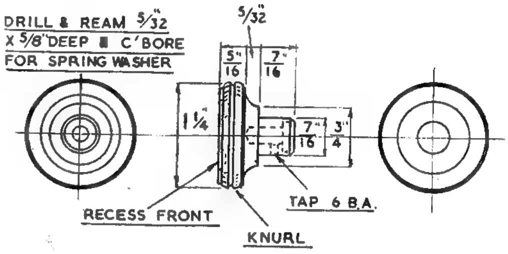
LOCKING LEVER
DURAL



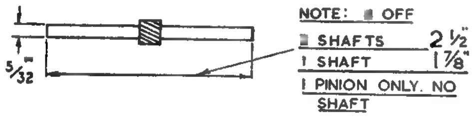
COARSE MOVEMENT KNOB
(2 OFF - DURAL)



LOCKING BOLT (DURAL)



DRAWTUBE RACKING KNOB
(2 OFF DURAL)



PINION DATA

OUTSIDE DIA.	0·250"
WIDTH	0·250"
NO. OF TEETH	14
DIAMETRAL PITCH	64
LEAD	1·5"
SPIRAL ANGLE R.H.	24° 36'
PITCH DIA.	0·2187"
CIRCULAR PITCH	0·0491"
DEPTH OF TOOTH	0·033"
CUTTER	No. 6

RACK DATA

LENGTH	1 AT 3" x ¼" THICK
"	2 AT 2" x ⅛" "
WIDTH	0·250"
ANGLE OF TEETH L.H.	65° 24'
DISTANCE BETWEEN TEETH	0·0491"
DEPTH OF TOOTH	0·033"
CUTTER	No. 1

DETAILS OF SMALL COMPONENTS, AND PINION AND RACK DATA

Those of you with little time, limited equipment, or, maybe, just faint hearts, may purchase suitable racks and pinions if you wish. Messrs. Turret Components, of Walthamstow, who advertise in this journal, will be able to help you, and can also supply suitable cutters if you decide to do your own work. If you buy your racks and pinions you will escape a considerable amount of accurate work—and lose a lot of fun and satisfaction. Excellent racks and pinions can be cut on the average 3½-in. lathe, but these components must be so designed as to be within the scope of the machine.

The chief concern of the designer must be with the pinion. To cut this it is necessary to provide some means of indexing—to obtain the correct number of teeth—and also some means of advancing and rotating the gear-blank against the revolving cutter, to obtain the helical form of tooth. The advance, or "lead," may be obtained by gearing the lathe mandrel to the leadscrew so that one complete turn of the mandrel advances the lathe carriage by the amount of lead required. The indexing may be obtained by dividing the change-wheel on the mandrel into a suitable number of parts, and re-meshing it for every tooth-cutting operation. The cutter must be mounted at the correct helix angle on the cross-slide, with some method of revolving the cutter.

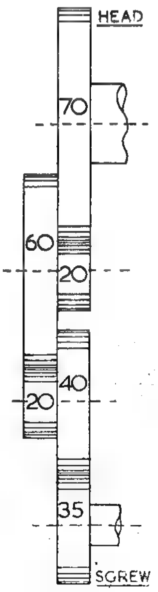


Fig. 12

The pinion data given conforms to requirements. It will be seen that a pinion of 14 teeth is cut on an outside diameter of ¼ in., using a cutter of No. 64 diametral pitch. The lead is 1.500 in. The spiral angle works out at 24 deg. 36 min., which may, for all practical purposes, be taken as 24½ deg. In designing helical gearing it is usual to assume, first, a suitable spiral angle and to let the lead take care of itself. In modifying the design for the lathe, it was necessary to start from the other end, as it were, and to select a lead which could be obtained with the ordinary standard change-wheels. By orthodox methods we should probably have been landed with a lead of, perhaps, 1.327 in., which could not have been set up on the lathe without using special change-wheels of odd and extraordinary numbers!

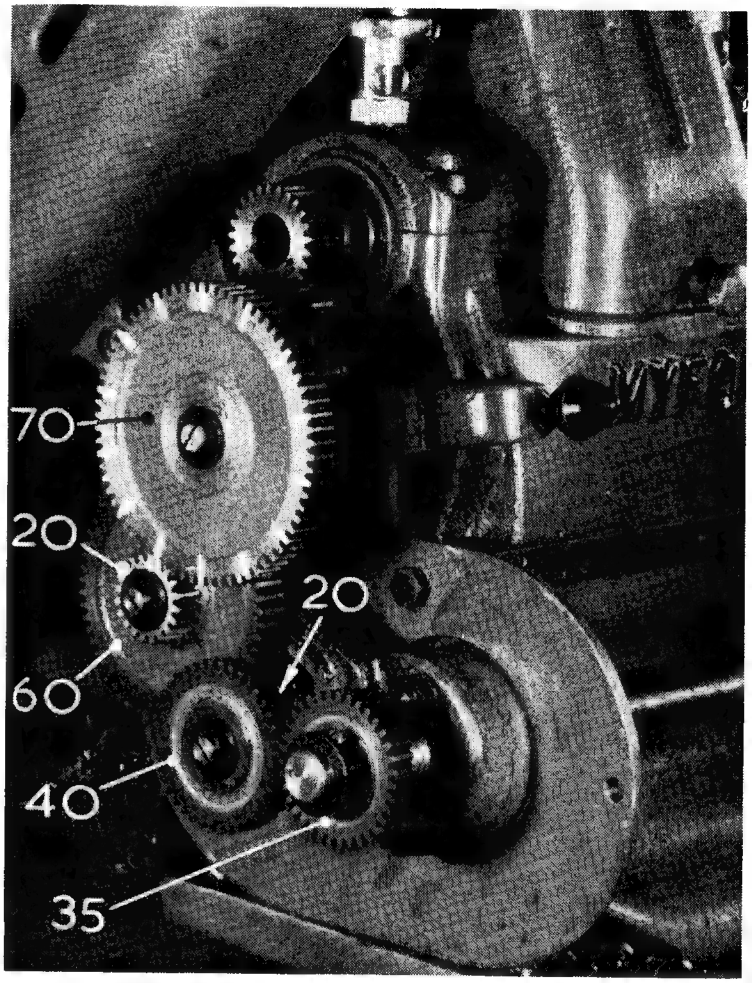


Fig. 11. *Changewheel set-up for helical gear-cutting. The leadscrew is geared up* 12-1 *to give a lead of* 1½ *in., while the* 70*-tooth changewheel is indexed to give* 14 *teeth*

As it is, the lead may be obtained by *gearing up* the usual 8 t.p.i. leadscrew in a ratio of twelve to one. This does, indeed, leave us with a spiral angle which is a little greater than is ideal for helical gears, which, for reasons of sidethrust is usually kept under 20 deg. In our case, where the load and speed of movement are very small, the slightly excessive sidethrust is of no account.

Now to the practical side of the matter. The photograph, Fig. 11, shows the manner in which standard change-wheels may be arranged to give the requirements. In this picture it has been necessary to mount the change-wheels "inside out," as it were, in order that the meshing of the 70 wheel with the 20 wheel might be shown. While retaining their exact order, the wheels will, in practice, be arranged as depicted in Fig. 12.

It will be particularly noted in the photograph that the 70-tooth change-wheel has every fifth tooth indicated by a chalk mark, and that, at the point where one of these marks engages with the 20-tooth change-wheel, two teeth of the smaller wheel have been similarly marked. We can, by lowering the quadrant, disengage these two gears. If, there-

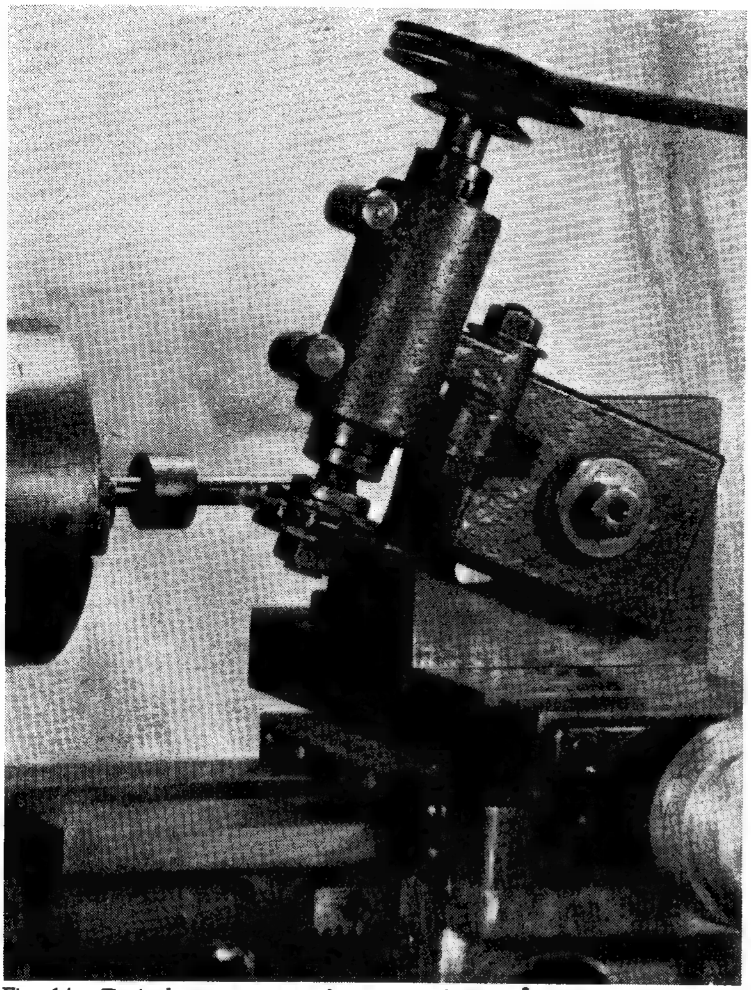


Fig. 14. Typical cutter set-up for cutting helical gearing. The cutter is inclined at the spiral angle of the gear, and depth of cut is controlled by movement of the cross-slide

fore, while thus disengaged, we revolve the 70-tooth, wheel a distance of 5 teeth, and then re-engage the chalk marks, we have turned the mandrel one fourteenth of a revolution, and the gear-blank, held in the chuck, will present a new portion to the cutter. Thus we may cut 14 equally spaced teeth.

The picture, Fig. 14, shows the business end of the set up. I would point out that this picture was specially arranged for photographic purposes, using a large blank and a large 20 d.p. cutter, because the small, $\frac{1}{4}$-in. diameter blank, and the 64 d.p. cutter—of only 20 mm. diameter—which are required for our actual pinion, are too small to photograph clearly. However, this is of no account, as the setting and method are identical.

Here will be seen the cutter, mounted on a suitable milling spindle, and driven by a leather belt. The cutter has be set at an angle of $24\frac{1}{2}$ deg.—the spiral angle of the teeth—to the axis of the blank. The picture shows that we are all set to cut the first tooth; that is, change-wheels are correctly chalked and engaged, the lathe carriage is engaged with the lead-screw, and the cutter fed in to the correct depth of cut by means of the cross-slide. The cutter is, of course revolving! To cut the tooth, the carriage is moved along the lathe bed by turning the handwheel of the leadscrew. This will also turn the gear train, causing the gear-blank to revolve, as the cut proceeds, at a lead of $1\frac{1}{2}$ in. Thus, the correct helical form is imparted. It will be found that the head will revolve quite easily when the leadscrew handwheel is turned, because, of course, we are geared down from leadscrew to head spindle, and not geared up as in ordinary screw-cutting. It will, in fact, be found impossible to revolve the leadscrew by turning the head spindle.

The only precautions necessary are against backlash, and one must be quite certain that all this is taken up before the cut is commenced. For this reason it is necessary to wind the carriage forward for some considerable distance along the lathe bed before the cutter engages with the blank. It is, of course, necessary to withdraw the cutter, by means of the cross-slide, at the finish of each cut, so that the carriage may be wound back for the re-start, setting the depth of cut again by the index dial. When cutting such small teeth it is possible to take the whole depth of tooth at one pass.

The milling spindle shown in the picture is one I have had for many years, and was made, I believe, by G. Potts, who still advertises in this journal. It is clamped to an ordinary angle-plate. As the cut is so light, an elaborate milling spindle is not required, and the constructor might easily improvise some such arrangement. It would, indeed, be possible to use an ordinary bicycle front wheel hub, clamped by a strip-steel strap to the angle-plate. The lower end of the spindle would carry an adaptor for the cutter, with a pulley adaptor at the other. I see no snags with this arrangement.

The drive may quite likely prove a bit of a problem, but it is quite probable that you may be able to adopt the same method as I did myself. On the same bench as the lathe, I have mounted a drilling machine, and it was found possible to clamp a pulley in the drill-chuck, and to drive through a long $\frac{3}{16}$-in. round leather belt. As the back and forth movement required is only about $\frac{1}{2}$ in., this was accommodated by the belt stretch. Such a small diameter cutter, taking such a light cut, may be run at a comparatively high speed—say around 150 to 200 r.p.m. I would point out that it is not even necessary for the drilling machine to be on the same bench as the lathe, as, provided there is a clear space between the two machines, the drive may be from any direction. The correct direction of rotation may be obtained by crossing the belt if this should be necessary.

The pinions may be made either integral with the 5/32-in. shafts, or with a 5/32-in. hole reamed through

(*Continued on page* 146)

MORE UTILITY STEAM ENGINES

By Edgar T. Westbury

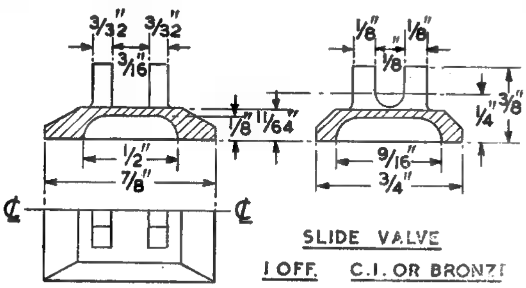
THE slide-valve may be made either from [redacted] casting, fabricated by silver-soldering, or machined from the solid; the third method is the one I generally prefer, but other constructors may have different views. Except where [redacted] cast-iron cylinder is employed, the valve should be made of a grade of material either harder or softer than the cylinder, if possible, to obtain the best wearing properties of the valve and port face. A good deal of the job can be roughed out in the lathe, and unless rectangular material of approximately the same cross section as the valve face is available, it is best to turn it to the approximate size over the corners, about 1⅛ in. diameter, and the projection on the back can be necked down to ½ in. diameter. The front face is also machined flat, and the cavity recessed slightly under ½ in. diameter by ⅛ in. deep, after which it can be parted off, and the rest of the work carried out by milling and filing.

The outside edges of the valve should be squared up, taking great care to get the length correct, in relation to the cylinder ports; [redacted] the valve is intended to have $\frac{1}{16}$ in. steam lap at each end, it should be ⅛ in. longer than the distance between the *outside* edges of the cylinder ports, and exactly symmetrical to the cavity, which should be equal in length to the distance between the *inside* edges of the ports, giving zero exhaust lap. These measurements, of course, [redacted] taken on the line of travel, [redacted] indicated by the centre-line on the half plan: the dimensions the other way are relatively unimportant, so long as the valve has clearance to slide freely in the steam chest, and the cavity is roughly as wide [redacted] the cylinder ports.

To square up the valve cavity, end milling is the accepted method, and in the absence of [redacted] milling machine, this can be done by holding the valve in a small machine vice on the vertical-slide, and running the end-mill in the chuck. Some constructors find it difficult to get [redacted] clean cut with small end-mills; the fact is that the normal type of lathe does not run anywhere near fast enough to use them to the best advantage, and the result is that they snatch and dig in. This particular job, however, can be done with an end-mill no smaller than $\frac{3}{16}$ in. diameter, and the fact that it leaves a radius in the corners of the cavity does not matter in the least A home-made flat cutter usually works better than a ready-made end-mill, one reason being that it can always be kept sharp without elaborate equipment. As shown in the drawings, the recess has no sharp corners but is rounded in the bottom; this can be done by using [redacted] round-nosed cutter, which will be found to cut cleaner than the normal square-ended cutter; but this detail is optional.

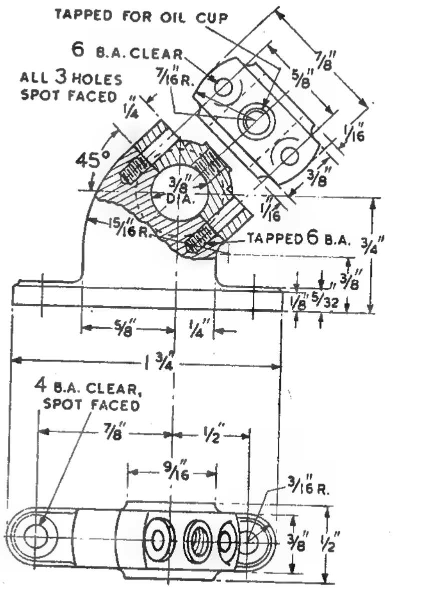
For further information on this and similar processes, see the "M.E." handbook *Milling in the Lathe*.

The slots on the back of the valve may also be milled, the important point being to get them true, relative to the control edges of the valve. In the direction of valve travel, the slot should be exactly on the centre-line, and should give free clearance to the valve rod; exactly at right-angles to this is [redacted] square-bottomed slot to accommodate the valve nut. All that remains to be done on this small but highly important component is to chamfer off the corners, either by milling or filing, and lap the face dead flat on [redacted] piece of plate-glass, [redacted] already described.



SLIDE VALVE

1 OFF. C.I. OR BRONZE



BEARING PEDESTAL 1 OFF BRONZE

Bearing Pedestals

Leaving the cylinder group of components for the time being, the major working parts at the other end of the engine may be dealt with. The first item here is the machining and erection of the main bearing pedestals, and as they are of somewhat unusual design, as compared to most horizontal engines, [redacted] brief explanation of their particular features may be called for.

The usual form of split bearings used on engines and other types of machinery, generically termed a

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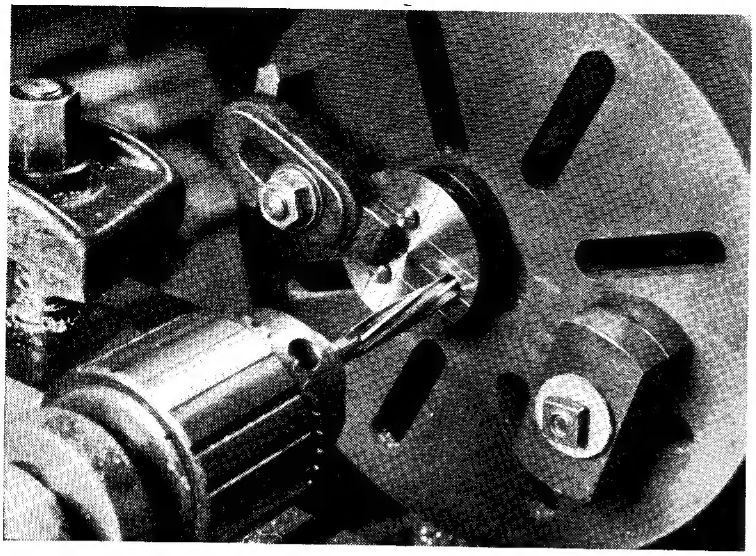


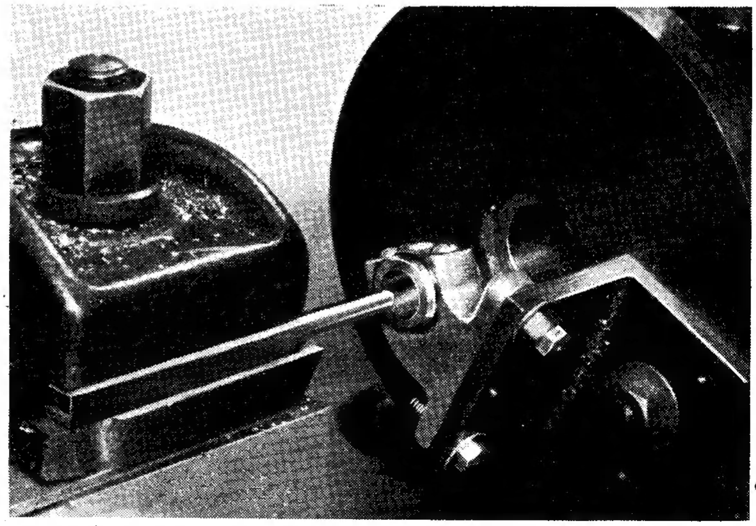
Crank discs, dowelled together and set up on faceplate for boring crankpin seatings

"plummer block," or in some cases "pillow block," consists of a pedestal with a detachable cap, arranged to carry split bearings. For purposes of convenience, in machining and erecting, the top and bottom surfaces of the pedestal are horizontal, but when a bearing of this type is used on a horizontal engine, the major working thrust is taken on the joint line. This did not matter a great deal in early engines which were of low power output in relation to size; but as steam engines developed, using higher steam pressures, and consequently greater loads on the bearings, it was found to give rise to bearing trouble. Many ingenious types of bearings were devised, and sometimes patented, to avoid this; but the simplest method of relieving the thrust on the "horns" of the bearings is to set the joint line at a substantial angle to the line of thrust. This was done on many of the later types of horizontal steam engines, and also on most gas and oil engines, though the latter usually dispensed with separate bearing pedestals by incorporating the bearing housings in the main bedplate casting, a feature also found in most marine steam engines.

In the present case the joint line of the bearing, is inclined at an angle of 45 deg. to the base, and although this involves slightly more difficulty in machining operations, it will be found well worth while. A point worth mentioning is that on this engine the pedestals are arranged so that the joint line is inclined away from the cylinder end, which is not quite so usual as the reverse arrangement. In the case of i.c. engines, which are normally single-acting, it is an advantage to incline the joint of the bearing so that the thrust is taken well down into the lower half, thereby relieving the top half, and particularly the bolts, from stress. The working thrust in a steam engine, however, is taken in both directions, so that it does not matter which way the bearing is inclined, and the arrangement adopted in this case is an advantage from the aspect of accessibility.

So much for "whys and wherefores." In the model engine, I have not considered it necessary to use separate inserted split brasses, and the bearings are formed in the pedestals themselves. Readers who wish to follow prototype practice strictly, however, may consider it worth while to bore the housings out larger and fit separate bearings; there is plenty of metal in the casting to enable this to be done. Incidentally, it is not *absolutely* necessary to split the pedestals, as the engine could be assembled by threading the bearings on to the shaft ends and then bolting them down, but one practical advantage of splitting them is that they can be bolted down first and their alignment checked before fitting the shaft.

The first operation on the pedestals is to machine the base surface, which can be done by holding them in the four-jaw chuck, but it will be necessary to use a packing piece on the overhanging side (right-hand side in the drawing), or the chuck jaws will force the casting over at an angle. After doing this, and before splitting the bearing, it is a good idea to drill and tap the holes for the cap studs. Unless a drilling machine with a tilting table is available (incidentally, I hate this fitting myself !) some form of angle fixture is necessary to hold the work at the required angle of 45 deg. I used a small angle plate made from



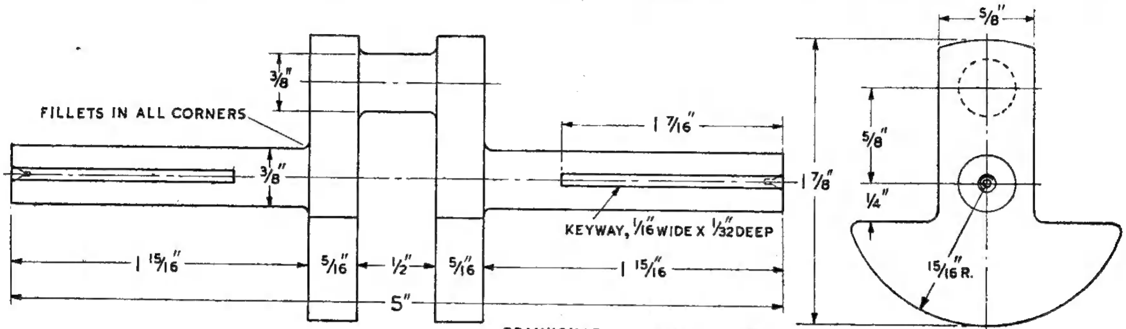
Boring out the bearing pedestals, mounted on an improvised miniature angle-plate on the driver plate or faceplate

a short length of ordinary angle-iron, duly trued up, and clamped to a larger angle-plate by a single bolt, which allowed angular adjustment; this was set up from the drill table by a combination square, using the mitre attachment. The holes for the mounting bolts were drilled in the pedestal, and used for fixing it to the small angle-plate; the bolts should fit closely, to ensure proper location of the work.

While mounted up for drilling, the two castings were marked off with a scribing block on the centre line (the casting is made with necessary allowance for splitting and facing the two surfaces); this ensured that both castings were marked at the same height from the base. Without detaching the casting from its mounting, it may be split, either by hand or by a slitting saw in the lathe, and the assembly set up on the lathe faceplate for facing off the joint surface, each casting being set up in turn, located by its fixing bolts, and faced off to the same index reading on the leadscrew or top-slide, so as to ensure uniform height. The caps, of course, will have to be faced separately, holding them across the four-jaw chuck, with due care to set them true both ways, though minor dimensional errors are not so important here. Don't forget to mark the two parts of each pedestal to ensure correct assembly; they may then be fastened together temporarily with screws.

It is now necessary to set up each pedestal in turn for boring the bearings; the miniature angle-plate is again just the very thing for this job, and the photograph shows how it can be mounted. Note that I am using the driver-plate, not the faceplate, as I find this more convenient for mounting small work, but it does not matter which is used so long as the desired result is achieved. The front of the boss on one of the castings should be marked out to locate the centre, and the angle-plate set up to centralise this exactly. It may then be faced, centre-drilled, pilot drilled, opened out, bored and reamed; the outside of the boss should also be skimmed up, but avoid cutting into the side face of the pedestal. The casting can then be dismounted and the other one put in its place for similar treatment, the angle-plate not being moved; in this way it is possible to ensure that the bearings will line up perfectly. To face and skim the outside of the boss at the other side of the bearing, the casting can be mounted on a pin mandrel.

A hole may be drilled and tapped in the centre of each bearing cap to take an oil cup; as some constructors may prefer to use ready-made lubricators, I have not specified the size or pitch of thread to be used, but I do not recommend making it larger than 5/32 in. × 40 t.p.i. In any case the lubricator should be in character; an oversize commercial lubricator or one which is obviously intended for cycles may be excellent from the "utility" aspect, but destroys all attempts to preserve realism.

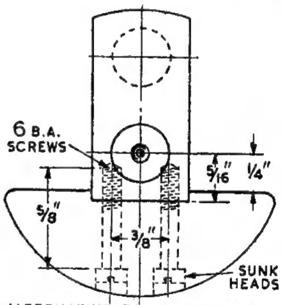


CRANKSHAFT 1 OFF M.S.

Erecting the Bearings

Having finished the machining operations on the bearings, they may as well be erected on the bedplate right away. First clamp both the bearings on a straight ⅜-in. mandrel (a piece of silver-steel or precision-ground mild-steel will do) at the correct distance apart, and check the base surfaces on a surface-plate. They should bed down quite squarely, but if not, the source of error should be found and corrected; it may be necessary to scrape the bases true. The mandrel should be of such a size that the bearings will grip on it when tightened down; if not, the caps may be lapped down to enable them to do so, as some final fitting of the bearings is sure to be found necessary afterwards.

The bearings, still mounted on the mandrel, are now laid on the bedplate in their correct location, and checked by clamping a straightedge to the outside of the cylinder support bracket, and measuring from this to the ends of the mandrel with a slide-gauge or inside calipers. This will ensure that the shaft axis is square with the cylinder centre-line. The bearings may now be clamped in place and the holes in the bedplate for the securing studs marked out It will be possible to spot the holes through from the inner sides of the bearing feet, and these may be drilled and tapped first, to hold the pedestals down temporarily; the other two holes can be spotted if the bearing caps are removed first, but keep the mandrel in place as a safeguard against inadvertent movement.



ALTERNATIVE FORM OF CRANK WEB WITH ATTACHED BALANCE WEIGHT

Note that the inner side of each bearing must be radiused to clear the fillet of the crankshaft journal; this can be done, after the location of each pedestal has been determined, by using the pin-mandrel to mount the bearing as before.

Crankshaft

This may be made by any of the well-known and approved methods; for the benefit of readers who are not familiar with them, they were fully described by me in an article published in the issues of THE MODEL ENGINEER dated March 7th to May 2nd, 1946.

Many readers like making crankshafts from solid round bar, between centres, in which case the material will need to be large enough to clean up 1⅞ in. diameter by 5 in. long. Less work, with economy of material, is entailed by using rectangular bar, ⅝ in. by 1¼ in. section, and attaching the balance weights as shown in the alternative drawing, which would be more in keeping with full size practice, as crankshafts were rarely, if ever, forged with integral balance weights. In either case, the machining technique is essentially the same, the centres being set out on the ends of the bar for main journals and crankpin; but when rectangular bar is used, it is possible to remove a good deal of unwanted material by drilling and sawing, before starting the machining operations.

By the way, I may mention that the crankshaft was one of the items which was missing from the engine on which this design was based, so I am unable to vouch for the strict accuracy of my reconstruction; but I have reason to believe that it did have balance weights (though many such engines did not) and that it had square-cut webs, as distinct from the type that was forged by bending a round bar.

In the actual construction of this engine, I used a built-up crankshaft, mainly as an experiment to see how it would work out. This is by no means an innovation in model engines, as built-up shafts are very common, but opinions are much divided as to their structural soundness, and also the problems in their ionstruction. In this case the shaft cs in four pieces, and assembled entirely by pressing, no brazing or other additional means of fixing being employed. Such a method is conducive to economy of material and also simplifies some of the processes, but its success depends entirely on scrupulous accuracy of individual parts, and correct limits in the dimensions of mating parts.

The crank webs were first made in the form of discs, machined on both sides, exactly parallel, and bored through the centre to a *larger* diameter than the shaft journals ($\frac{7}{16}$ in. diameter), the outer edge being left slightly oversize. One of the discs was marked to show the outline of the web and the crankpin centre, and the two were dowelled together by a short piece of $\frac{7}{16}$ in. rod, made a tight fit in the centre-hole. As a further measure to ensure rigid alignment, two holes were drilled and tapped to take 4-B.A. screws, in a part of the web which afterwards was cut away; as a matter of fact their location was arranged so that they produced the radius at the intersection of the two sawcuts. This will be quite clear in the photograph showing the discs set up on the faceplate for boring and reaming the hole for the crankpin, which was also made oversize.

A second dowel was fitted in the crankpin hole, and the discs were mounted in the lathe toolpost for sawing out the unwanted metal with a circular saw. Some cleaning up of the cut edges was necessary, as it was desirable that these should be as square and accurate as possible to facilitate alignment during assembly.

The journals and the two ends of the crankpin were machined to an interference fit, approximately 0.001 in. larger than the bore of the holes; the simplest way to be sure of this is to first turn up a piece of metal which will just push fairly stiffly into the holes; measure this carefully with the micrometer, and turn the mating parts just 0.001 in. larger, full rather than bare. It is most essential that the finish of the parts, both internal and external, should be as high as possible, as any roughness will result in bearing on the high spots only; if any doubt exists, lap both parts, but do not reduce the interference allowance.

In most cases where shafts are built up in this way, it is regarded as a good policy to make the main shaft in one piece, fitting both webs to it, and cutting out the gap after assembly is completed. The general idea is that it will keep things in perfect alignment and ensure that the finished shaft will run true. This seems logical enough, but having tried it on several occasions, including the first attempt with this shaft, I have not found it successful in practice. All seems to go well until the centre of the main shaft is cut out, when the assembly invariably springs out of truth. In the present case, I turned all the components to finished size, except the outside edge of the webs; the main shafts, which were turned between centres, were first pressed into their respective webs, and the latter tested for any trace of side wobble, before pressing the crankpin into each web in turn. Tallow was used as a lubricant.

When inserting the crankpin in the second web, a straight-edge was used on the sides of the webs to check alignment, and before pressing in very far, a further and more precise check was made by holding one journal in a collet chuck and testing the true running of the other with a dial test indicator. At this stage it is possible to correct any inaccuracy with a few judicious taps with a mallet, after which the crankpin is pressed fully home.

The pressing in was done with the bench vice—not at all the ideal weapon for the job, as its parallelism is not very positively maintained; but short of making up a special press for the job, I do not know of any ready-made appliance, in a convenient size to suit this work.

(To be continued)

A RESEARCH MICROSCOPE

(Continued from page 142)

them, in which case they may be sweated to silver-steel shafts afterwards. Great care must be taken, however, to see that the hole is truly central with the outer diameter of the pinion, as otherwise it will be impossible to avoid backlash, or a tight and loose movement, in operation.

The racks do not require the somewhat elaborate set-up that the pinions demand. The cutter is mounted on a mandrel between centres, and driven from the headstock of the lathe. The blank must be mounted, at the correct angle, 65 deg. 24 min., to the lathe ways. This should be done with a protractor as carefully as is possible, but an error of a couple of minutes or so will not be too important.

The blank may either be packed up to the correct height for depth of cut on the cross-slide, or mounted on a platform at a right-angle to the vertical-slide, which is bolted to the cross-slide. Depth of cut is important, as this affects the thickness of the teeth.

Tooth spacing is determined by the indexing on the leadscrew handwheel; the lathe carriage being moved forward the correct distance for each cut. The absolutely correct distance between teeth is 0.0491 in., but the odd tenth of a thou. may be ignored.

When the racks and pinions are finished, each pair may be lightly lapped together with metal polish to remove burrs, rough places, and to relieve, as far as possible minute errors in setting and spacing. This lapping must be done very sparingly, and must not be relied upon to compensate for hopelessly bad work. It won't!

(To be continued)

QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

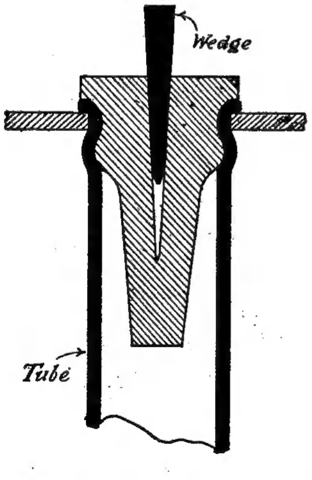
(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Expanding Boiler Tubes

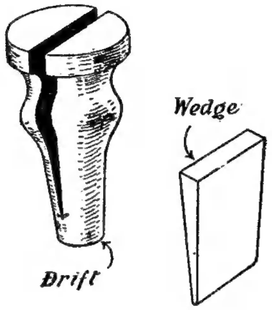
I am making a small vertical boiler, and propose to expand the tubes into the upper and lower plates as in full-size practice. Will you please inform me how this is done, and what tools will be required; also advise me whether the method is satisfactory for small boilers?

R.G. (Preston).

It is quite practicable to fit tubes of any size by this method, but it demands care, and the surfaces must be accurate and well finished with all burrs removed, especially in small boilers. The tube plates must be thick enough to provide a firm hold for the tubes, without risk of swelling or distortion of the holes, and the tubes must be well annealed before fitting. In some cases satisfactory results have been obtained by using a tapered drift to expand the tubes,



but it is better to use a special tool which expands them on both sides of the seating in the tube plate. For large boilers, a roller tool is commonly employed, but this would be difficult to make in a small size, and the split drift or "dolly" will give good results if carefully used. It is



placed in the tube as shown and the wedge driven in to expand the tube, this process being repeated several times with the drift turned slightly each time. The amount of bulge on the drift, as shown in the sketch, is exaggerated.

Renewing Bearings

I wish to renew the bearings of an industrial machine, which have worn so badly that the operation is noisy and erratic. At present, the "bearings," if they can be so called, are simply holes drilled in the cast frames of the machine, and I propose to bore them out and fit bronze bushes, as there is plenty of metal in the bosses to allow this. The mechanism includes toothed gearing, and as the holes are worn oval, how can I be sure of getting the centres of the holes the correct distance apart? What precautions can I take to ensure that the holes are correctly aligned in the side frames? Can the work be done without dismantling the machine completely?

H. W. (Swindon).

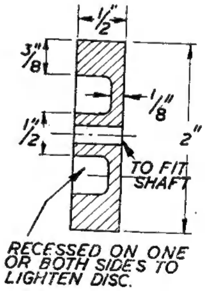
The problem of reboring the holes at exactly the correct centres with limited equipment, is one that is by no means easy to solve. If it is possible to measure the gears accurately, it may be possible to set out all the gear centres in their correct relative positions on a template; if the gears are cut to standard diametral pitches, and are not badly worn, this may be practicable. The template might then be attached to each of the frames in turn, locating from known positions such as tie bolts, and the marked centres used as setting points. If the machine cannot readily be dismantled, the same general idea might be employed, but making a pair of jig plates with holes which could be used to guide a boring bar with cutters to open out the existing bearings; the bar being turned by hand or other convenient means, and feed applied by a jack screw bearing on the end of the bar. This method would ensure correct alignment of the holes in the two frames. Another method would be to bore out the holes without attempting to correct the centres, and fit blank inserts, on which the centres are set out by measurement, and bored *in situ*; alternatively, eccentric bushes with means of turning them after insertion for adjusting centre positions, might be used, but these would not give positive alignment of the shafts.

Flywheel for Compression-Ignition Engine

Please would you give me the size and weight of a flywheel for the 1.5 compression-ignition engine described by "Battiwallah" in the "M.E." August 26th, 1948.

W.K.H. (Bexleyheath).

The weight and size of a flywheel for a 1.5 c.c. compression-ignition engine is not at all critical, and can hardly be assessed in terms of weight, as it is the distribution of weight which counts more than actual weight.



We suggest that a flywheel of 2 in. diameter, with a rim $\frac{1}{2}$ in. wide by $\frac{3}{8}$ in. radial thickness, would be quite satisfactory. The wheel will, of course, require a boss of adequate size to enable it to be properly secured to the shaft, but the remaining portion of the flywheel disc may be very considerably lightened down. It should be made either of brass or mild-steel.